INSTRUCTION MANUAL

MODEL 129

AM / FM FUNCTION GENERATOR

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EXACT electronics, inc.
Box 160 Hillsboro, Oregon
97123 Tel. (503) 648-6661
TWX 910-460-8811
A subsidiary of Danalab, Inc.

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.
2. Check fuse and power supply voltages.
3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION 1

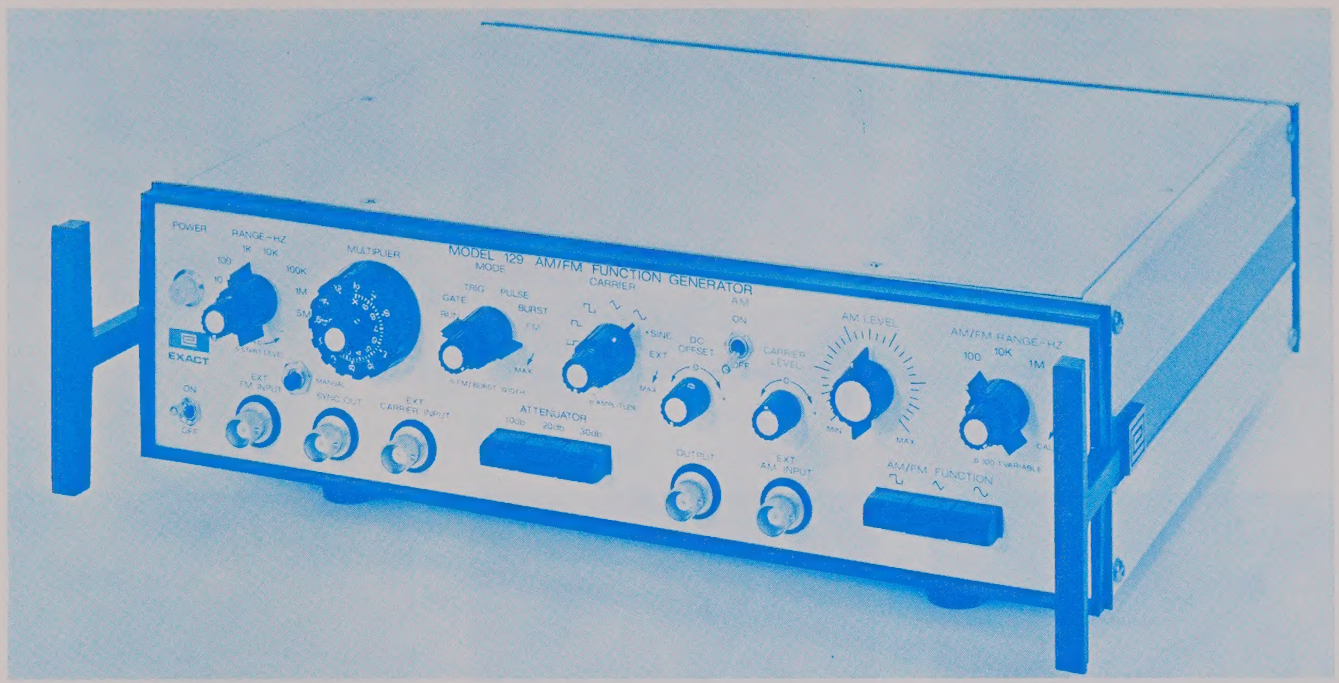
SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

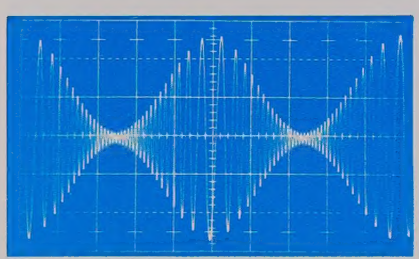
NOTES

MODEL 129 AM/FM FUNCTION GENERATOR

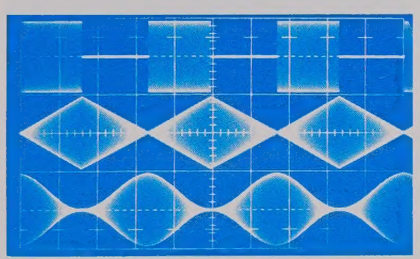


FEATURES

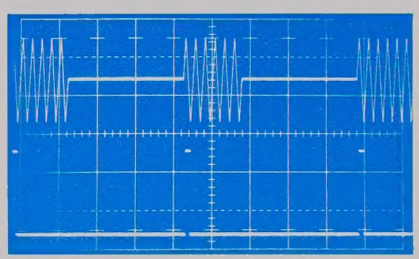
- WAVEFORM GENERATOR — SINE, SQUARE, TRIANGLE, ± PULSE, +SINE
- AM GENERATOR
- FM GENERATOR (1000:1 RANGE)
- SIMULTANEOUS AM/FM
- INTERNAL AM/FM SOURCE
- PULSE GENERATOR — VARIABLE WIDTH AND REPETITION RATE
- TONE BURST GENERATOR
- GATE/TRIGGER
- VARIABLE D.C. OFFSET
- SEARCH MODE FOR MANUALLY SWEEPING OVER THREE DECADES
- FLOATING OUTPUT PROVISION
- OUTPUT AMPLIFIER WITH 60db ATTEN IN 10db STEPS + 20db VAR USABLE TO 120db ATTENUATION (10μV PP INTO 50Ω) IN AM MODE



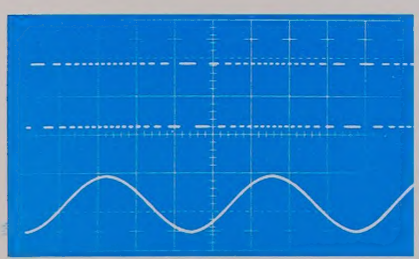
SIMULTANEOUS AM/FM MODULATION



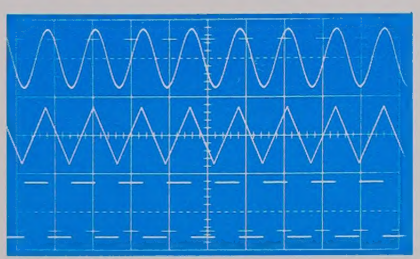
SQUARE, TRIANGLE AND SINEWAVE AM



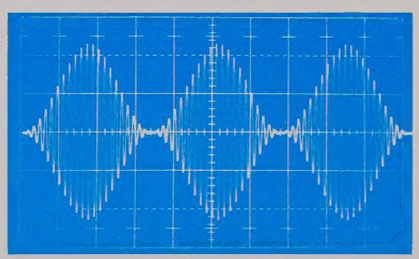
BURST MODE — PULSE MODE



FREQUENCY MODULATION, SQUARE WAVE CARRIER



SINE, TRIANGLE AND SQUARE



100% SINE WAVE AM

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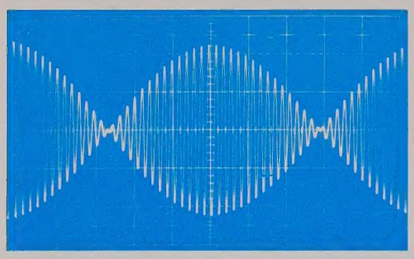
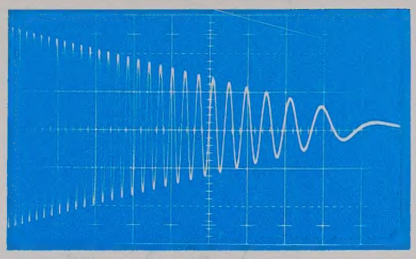
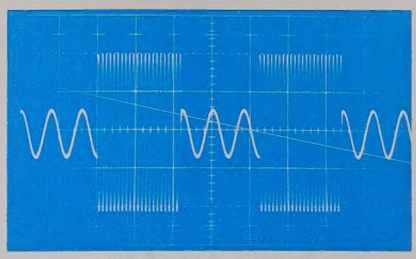


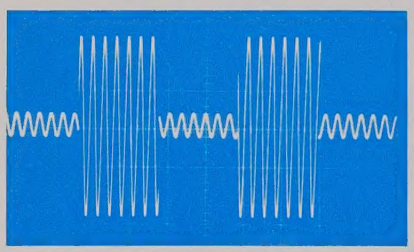
AM SUPPRESSED CARRIER



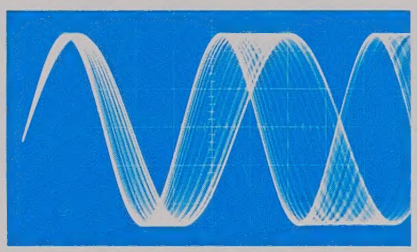
LINEAR AM/FM



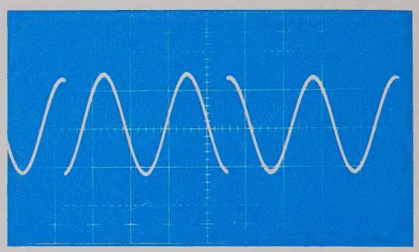
AM/FSK MODULATION



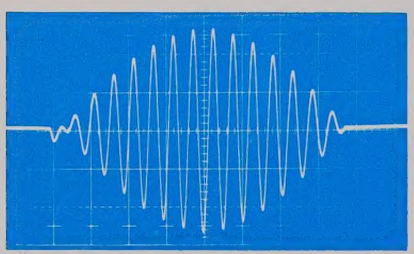
SQUARE WAVE AM



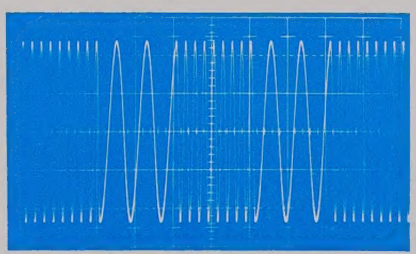
LOW FREQUENCY FM



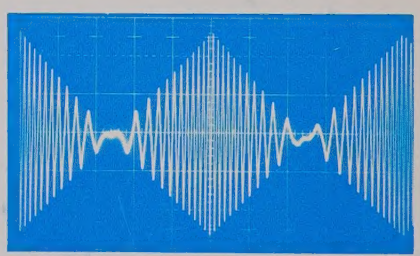
PHASE SHIFT KEYED



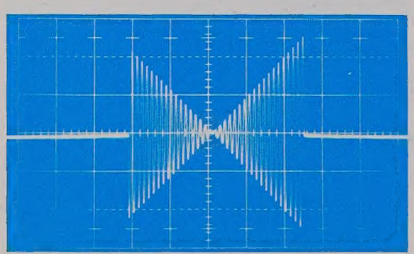
HALF SINE AM BURST



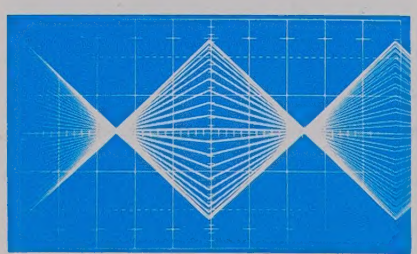
FSK



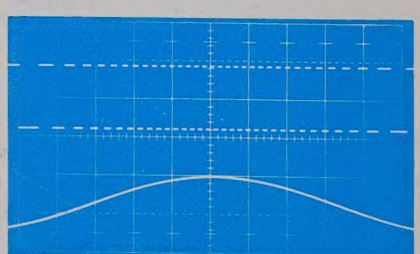
TRIANGLE AM SUPPRESSED CARRIER



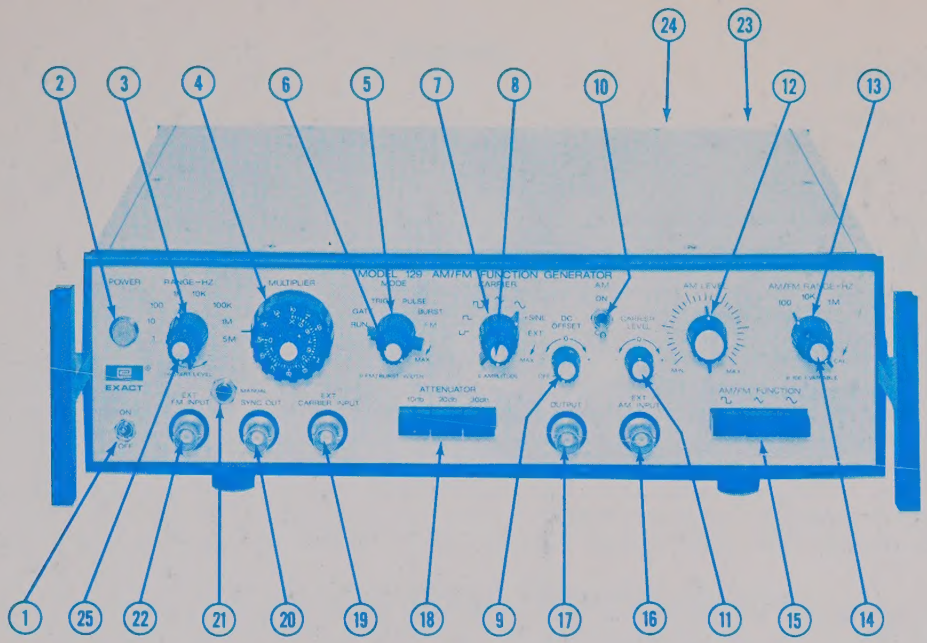
MODULATED TONE BURST (BOW TIE)



ULTRA LOW FREQUENCY AM



LINEAR FM SINE WAVE MODULATION



MODEL 129 AM/FM FUNCTION GENERATOR OPERATION

1. Power On/Off switch — Connects line voltage to the instrument.
2. Pilot Lamp — Visual indication when instrument is on.
3. Range Switch — Selects the desired range of carrier frequencies.
4. Multiplier — Provides calibrated fixed frequency steps between range settings. Each Step equals 10% of range setting. The vernier dial provides variable frequency adjustment between fixed steps.
   The "S" position on the fixed step multiplier dial places the multiplier in the search mode. The search position allows the vernier dial complete control of the frequency over a three decade range.
5. Mode Switch — Selects the desired mode of operation.
   RUN MODE—The carrier generator will free run continuously.
   GATE MODE—The carrier generator will stop running. The generator will free run only when an external signal is applied at the external trigger input or when the manual pushbutton is depressed. The generator will stop running on removal of the signal after completing the cycle it is generating.
   TRIG MODE—The carrier generator will stop running. The generator will run for one complete cycle when an external signal is applied to the Ext Trig in connector or each time the manual pushbutton is depressed.
   PULSE MODE—The pulse mode is similar to the trig mode above. The AM/FM generator triggers the carrier generator "on" for one complete cycle at the AM/FM generator rate. This allows pulsing of all carrier waveforms.
   BURST MODE—The AM/FM generator is connected internally to gate the carrier generator "on" and "off" at the AM/FM generator rate.
   FM MODE—The AM/FM generator will frequency modulate the carrier generator internally when in the FM Mode.
6. FM/Burst Width — Provides adjustment of the FM (sweep) width when in the FM Mode and Burst width in the Burst Mode.
7. Carrier Switch —Selects the desired carrier or output waveform desired. The Ext Position allows the use of an external carrier waveform.
8. Amplitude — Provides >20db variable attenuation of the output signal. Amplitude control has no effect on carrier level or AM level adjustment. (Percent of modulation.)
9. DC Offset — When switched on, provides variable control of the DC level of the output waveform.
10. AM Switch — Allows amplitude modulation of selected carrier waveform.
11. Carrier Level — When in the AM Mode, this control provides complete adjustment of the carrier amplitude from max "pos" thru "null" to max "neg." 180° Phase Shift occurs from Max + to max - setting. May be utilized as a variable PHASE CONTROL.
12. AM Level — This control adjusts the amount of AM signal applied to the modulator. The desired amount of modulation is adjusted by means of the carrier level and/or the AM level controls.
13. AM/FM Range — Selects the desired frequency range of the AM/FM generator.
14. 100:1 Variable — Provides variable adjustment of AM/FM frequency between fixed ranges. This control allows adjustment over a two decade range (100:1).
15. AM/FM Function — A Square, Triangle or Sine waveform may be selected to amplitude modulate the carrier waveform selected by the carrier switch. Simultaneous AM/FM may be obtained by placing the mode switch to FM and the AM switch on.
    The selected waveform from the AM/FM function switch will AM and/or FM the carrier signal selected.
    FM width, AM level, and Carrier level are all independent of each other.
16. External AM Input — When in the AM Mode, an external signal may be used to AM the carrier waveform selected. The AM level must be set to min to avoid mixing of the internal and external AM signal, unless mixing is desirable.
17. Output — BNC output connector providing the selected carrier at 50Ω output impedance for connection to external equipment.
18. Attenuator — A pushbutton attenuator providing a 10, 20 and 30db Pad for a total attenuation of 60db in 10db steps.
19. External Carrier Input — An external carrier or signal may be used when the carrier switch is in the Ext position. Amplitude modulation of this external waveform is easily accomplished utilizing the AM/FM generator or an external AM input.
20. Sync Out — Provides a square wave for syncronizing external equipment to the carrier generator.
21. Manual Pushbutton — The Manual pushbutton allows manual gating and triggering of the carrier generator in the gate and trig mode of operation.
22. External FM Input — Provides external control of frequency for FM, sweeping, frequency shift keying, DC frequency control etc. . . . .
23. External Trigger Input — When in the gate and trig mode, the carrier generator may be externally gated or triggered by application of an external signal at the external trigger input.
24. AM/FM Sync Output — Provides a square wave for syncronizing external equipment to the AM/FM generator.
25. Start level — When the carrier generator is in the gate, trig, pulse or burst mode of operation, the start level provides adjustment of the start phase over a ±90° range.

GENERAL

The Model 129 is two generators in one small unique package. The main generator is a VCF (voltage controlled frequency) generator, producing sine, square, triangle, ±square, ±pulse, +sine and sync waveforms over a dynamic frequency range of 0.1 Hz to 5 MHz. The AM/FM generator produces sine, square, and triangle waveforms over a frequency range of 1Hz to 1MHz. It is also used to gate or trigger the main generator for tone-burst and pulse generator operation.

Simultaneous AM and FM is provided by selecting both AM and FM with the mode switches. Percent of modulation can be set with either carrier level or AM level and the percent of modulation remains constant for all levels of output settings. Percent of modulation is adjustable from 0% through 100% and on to double sideband suppressed carrier.

A search mode is provided using the Kelvin-Varley frequency multiplier vernier, so the main generator can be manually swept over three decades. In the pulse mode, pulse duration as well as repetition rate are variable. The main generator can also be manually or externally gated or triggered. External amplitude and frequency modulating signals can be applied to AM and/or FM the main generator. An external carrier mode is provided to allow the Model 129 to modulate other signals. The AM/FM generator sync output (square wave) is available at the output connector on the rear panel. The output amplifier has a 60db step attenuator in 10db steps and 20db variable plus 60db carrier level for greater than 120db attenuation and ± 10V of variable D.C. offset.

The Model 129 is actually a combination SINE, SQUARE, TRIANGLE, AM, FM, VCF, SWEEP, TONEBURST, PULSE GENERATOR in one versatile package.

SPECIFICATIONS

WAVEFORMS
Sine, Square, Triangle, Positive Pulse, Negative Pulse, Positive Square, Negative Square, Positive Sine.

DYNAMIC FREQUENCY RANGE
Main generator, 0.1Hz to 5MHz.
AM/FM generator, 1Hz to 1MHz.

MODES OF OPERATION
Run, Gate, Trigger, Pulse, Burst, FM, AM, Simultaneous AM - FM, Ext. carrier.

SYNC OUTPUTS
Main generator, square wave approximately 2 V P-P open circuit. Approximately 100Ω output impedance.

AM/FM generator: square wave approximately 100Ω output impedance. Located on rear panel.

FREQUENCY ACCURACY
Main generator, ±2% of frequency range (typically ±2% of setting).

AM/FM generator: 1Hz to 1MHz in three calibrated steps. Accurate within ±5%. Uncalibrated continuously variable between steps: variable has 100:1 range down from calibrated step.

OUTPUT
50Ω output impedance. All waveforms 20V P-P open circuit. 10V P-P into 50Ω with exception of Positive and Negative Square and Positive Sine which are 10V peak open circuit, 5V peak into 50Ω. A full 80db of attenuation is provided in 10db steps with 20db continuously variable (greater than 120db utilizing carrier level in AM mode).

GATE AND TRIGGER MODES
Input: D.C. coupled, input impedance approximately 5K. Trigger and gate signal requirements, manual or external voltage of approximately 1.2V for turn on. TTL compatible located on rear panel.

EXTERNAL AM INPUT
Approximately 10V P-P for 100% modulation at full output. Frequency response, 1db down at 1MHz.

EXTERNAL FM INPUT
Approximately 5V P-P for Maximum deviation.
Slew rate limit approximately 0.1V/μsec.

EXTERNAL CARRIER INPUT
Approximately 10V P-P for full output.
Frequency Response, 3db down at 10MHz.

SINE WAVEFORM DISTORTION
<0.5% 0.1Hz to 100KHz (Typically <0.2%). No harmonics. <30db down 100KHz to 5MHz

SINE FREQUENCY RESPONSE
0.1db to 100KHz, 0.5db to 5MHz.

SQUARE WAVEFORMS
Rise and fall <50 nanoseconds.
Overshoot and ringing <5%.

TRIANGLE LINEARITY
99% to 100KHz, 95% to 5MHz.

D.C. OFFSETS: Variable ±5V into 50Ω, ±10V open circuit. D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

FREQUENCY STABILITY
0.05% of setting for 10 min.,
0.25% of setting for 24 hrs.

AMPLITUDE STABILITY
0.05% of maximum P-P amplitude for 10 min.,
0.25% of maximum P-P amplitude for 24 hrs.

SYMMETRY (time): ±1%

POWER REQUIREMENTS
Input Voltage — 115% VAC ±10% or 230 VAC ±10%.
Frequency — 50 to 400Hz.
Power Consumption — Approximately 20W.

PHYSICAL CHARACTERISTICS
12½" wide × 3½" high × 10½" deep. Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

PRICE: (f.o.b. Hillsboro, Oregon).
Option "B" $50 — 0.01Hz — 5MHz. Main generator.
Option "G" $50 — 0.01Hz — 1MHz AM/FM generator.

NOTE: (unless otherwise stated). Specifications apply 10% to maximum output voltage with instruments terminated into 50Ω and do not apply in the Search Mode or AM Mode. Specifications are valid at 25°C ±5°C warmup-time of 30 min.

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VERIFICATION OF SPECIFICATIONS

Following is a list of test equipment required to validate the specifications of the Model 129 AM/FM Generator.

Test equipment with accuracy equal to the following list of test equipment will be acceptable for specification validation.

Oscilloscope, DC to 50MHz
Plug-In, Differential 20mv/cm sensitivity
Counter/Timer, .1μsec time base
DVM, .01% accuracy
Harmonic Distortion Analyzer, less than 0.1% residual distortion
Spectrum Analyzer, 1KHz to 100MHz

NOTE: Allow 60 minutes for warm-up.

FREQUENCY ACCURACY:

Main Generator:

1. Set controls as follows:

RANGE	1K
MULTIPLIER	1.0
MODE	RUN
CARRIER	TRI
ATTENUATORS	OFF (OUT)
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

2. Connect the Counter/Timer to the Sync Output jack on the front panel with an appropriate coaxial cable to the A.C. input.

3. Observe time interval on counter of 1000μsec ±20μsec.

4. Set Range to 100. Observe time interval of 10msec±.2msec.

5. Set Range to 10. Observe time interval of 100msec ±2msec.

6. Set Range to 1. Observe time interval of 1000msec ±20msec.

7. Set Multiplier to .10. Observe time interval between 8.33sec and 12.50sec.

FREQUENCY ACCURACY, Main Generator (Continued)

8. Set Range to 10. Observe time interval between 833msec and 1250msec.
9. Set Range to 100. Observe time interval between 83.3msec and 125msec.
10. Set Range to 1K. Observe time interval between 8.33msec and 12.5msec.
11. Set Range to 10K. Observe frequency of 1KHz ±200Hz.
12. Set Range to 100K. Observe frequency of 10KHz ±2KHz.
13. Set Range to 1M. Observe frequency of 100KHz ±20KHz.
14. Set Range to 3M. Observe frequency of 500KHz ±100KHz.
15. Set Multiplier to 1.0 Observe frequency of 5MHz ±100KHz.
16. Set Range to 1M. Observe frequency of 1MHz ±20KHz.
17. Set Range to 100K. Observe frequency of 100KHz ±2KHz.
18. Set Range to 10K. Observe frequency of 10KHz ± .2KHz.
19. Set Range to 1K. Observe frequency of 1KHz ±20Hz.
20. Set Multiplier to .50. Observe frequency of 500Hz ±20Hz.
21. Set Multiplier to 1.0

AM/FM GENERATOR

1. Connect the Counter/Timer to the AM/FM Sync Output on rear panel with an appropriate coaxial cable to the AC input.
2. Set 100:1 VAR to CAL position.
3. Set AM/FM Range to 1MHz. Observe frequency of 1MHz ±50KHz.
4. Set AM/FM Range to 10KHz. Observe frequency of 10KHz ±500Hz.
5. Set AM/FM Range to 100Hz. Observe period of 10ms ± .5ms.
6. Set 100:1 VAR full CCW. Observe period > 1sec.
7. Set AM/FM Range to 10KHz. Observe period >10ms.
8. Set AM/FM Range to 1MHz. Observe frequency <10KHz.

FREQUENCY ACCURACY, AM/FM Generator (Continued)

9. Set 100:1 VAR to CAL and AM/FM Range to 10KHz.

TIME SYMMETRY

1. Connect the Counter/Timer to the Sync output jack on the front panel.
2. Set Range to 10K.
3. Set Multiplier to 1.0.
4. Set Counter/Timer to read time interval A to B and B to A. Observe time symmetry error $<$ 1%.
5. Set Range to 1K. Observe time symmetry error $<$ 1%.
6. Set Range to 100. Observe time symmetry error $<$ 1%.
7. Set Range to 10. Observe time symmetry error $<$ 1%.
8. Set Range to 1. Observe time symmetry error $<$ 1%.
9. Set Multiplier to .10. Observe time symmetry error $<$ 1%.
10. Set Range to 1K.
11. Set Multiplier to 1.0.

FREQUENCY STABILITY

Observe that the frequency remains within 0.05% for 10 minutes.

SYNC OUTPUT

1. Connect oscilloscope to the Sync output on front panel with an appropriate coaxial cable.
2. Observe square wave of approximately 2V P-P open circuit.
3. Connect oscilloscope to the AM/FM Sync output on rear panel.
4. Observe Sync pulse approximately 2V P-P open circuit.

CARRIER OUTPUT

1. Set amplitude to MAX. Connect the main output to the oscilloscope with a 50Ω coaxial cable terminated into 50Ω.
2. Observe Tri $>$ 10V P-P.

CARRIER OUTPUT (Continued)

3. Switch through square, triangle and sine waveform, observing > 10V P-P amplitude.

4. Switch to negative square, positive square, and + sine observing > 5V peak amplitude.

5. Remove 50Ω terminator and observe > 20V P-P open circuit for square, triangle and sine waveforms and > 10V peak for positive and negative square and + sine.

6. Add 50Ω terminator, set attenuator 10db, 20db, 30db, 40db, 50db, and 60db and observe corresponding attenuation.

7. Rotate amplitude vernier and observe another 20db of attenuation.

8. Set amplitude to MAX, attenuator to 0db. (out)

GATE AND TRIGGER MODES

1. Set:

MODE	GATE
START LEVEL	0

2. Monitor output with oscilloscope.

3. Apply signal at Trig input jack, increase signal and observe main generator runs at approximately 1.2V of signal.

4. Depress Manual pushbutton and observe generator runs when button is depressed.

5. Set:

MODE----------TRIGGER

Apply signal at trigger input. Increase signal and observe main generator produces one complete cycle when trigger input rises to approximately 1.2V.

6. Depress Manual pushbutton and observe one complete cycle each time the Manual pushbutton is depressed.

SINE WAVE DISTORTION

1. Set:

MODE	RUN
RANGE	10K
MULT	1.0
AMPLITUDE	MID RANGE
FUNCTION	SINE

SINE WAVE DISTORTION (Continued)

2. Connect distortion analyzer to the output, terminated into 50Ω. Measure sine distortion of <.5%, typically .2%.

3. Set Range to 100K and measure sine distortion <.5%.

4. Set Range to 5M. Connect spectrum analyzer to main output jack and measure harmonic content. Observe no harmonics <30db down.

SINE FREQUENCY RESPONSE

1. Set Range to 10K.

2. Connect oscilloscope to output terminated into 50Ω.

3. Observe sine wave amplitude.

4. Set Range to 100K. Observe sine amplitude drop <.1db.

5. Set Range to 5M. Observe sine amplitude drop <.5db.

SQUARE WAVEFORM

1. Set:

RANGE	1M
FUNCTION	SQUARE
AMPLITUDE	MAX

2. Connect output through a 50Ω coaxial cable terminated into 50Ω to the oscilloscope.

3. Observe risetime and falltime of square <50ns at main output.

4. Observe overshoot and ringing <5% of P-P amplitude.

D.C. OFFSET

1. Set Range to 1K, amplitude vernier to MIN.

2. Rotate D.C. offset switch and observe D.C. level shift ±5V into 50Ω.

3. Remove terminator and observe D.C. level shift ±10V open circuit.

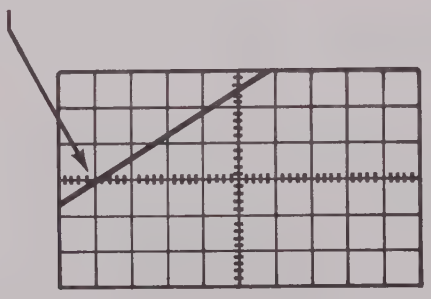
NOTE: D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

AMPLITUDE STABILITY

1. Set amplitude to MAX, D.C. offset to OFF, function to TRIANGLE.
2. Connect output through a 50Ω coaxial cable terminated into 50Ω.
3. Set plug-in sensitivity to 20mv/cm.
4. Measure accurately the positive peak of triangle and negative peak of triangle and record.
5. Wait 10 minutes and measure positive and negative peaks again. Observe amplitude change $<$ 10mv.

TRIANGLE LINEARITY

1. Connect the output to the differential plug-in through a 50Ω coaxial cable terminated into 50Ω.
2. Adjust oscilloscope to obtain one-half cycle of triangle across full horizontal grid on oscilloscope CRT.
3. Set differential plug-in sensitivity at 20mv/cm.
4. Adjust comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below:



5. Record reference voltage using DVM accurate to 1mv.
6. Adjust comparison voltage until slope of triangle intersects next major horizontal grid mark.
7. Record accurately the new reference voltage.
8. Repeat to obtain as many points as desired.

TRIANGLE LINEARITY (Continued)

9. Calculate linearity and observe linearity is 99% or better.

NOTE: Horizontal time base accuracy of oscilloscope and accuracy of DVM are important to obtain meaningful data.

SECTION 2

OPERATING INSTRUCTIONS

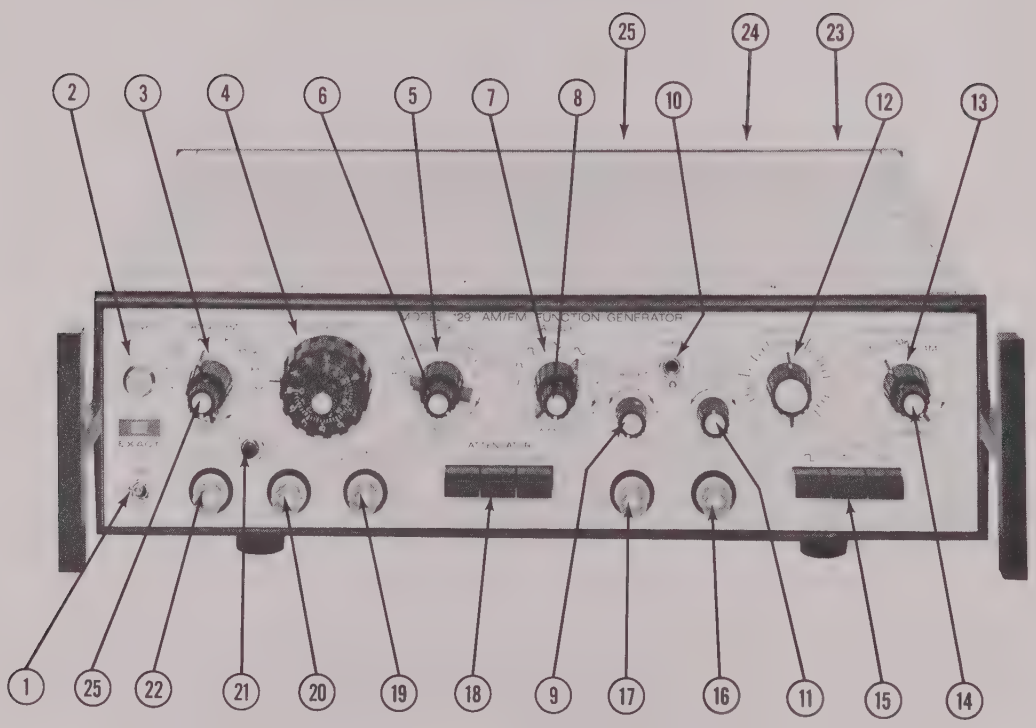


FIGURE 2.2.1
FRONT AND REAR
PANEL FAMILIARITY

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

1. POWER ON/OFF SWITCH - Connects line voltage to the instrument.

2. PILOT LAMP - Visual indication when instrument is on.

3. RANGE SWITCH - Selects the desired range of CARRIER frequency.

4. MULTIPLIER - provides calibrated fixed steps between range settings. Each step equals 10% of range setting. The vernier dial provides variable frequency adjustment between fixed steps.

   The "S" position on the fixed step MULTIPLIER dial places the MULTIPLIER in the search mode. The search position allows the vernier dial complete control of the frequency over a three decade range.

5. MODE SWITCH - Selects the desired mode of operation.

   RUN MODE - The carrier generator will free run continuously.

   GATE MODE - The carrier generator will stop running. The generator will free run when an external signal is applied at the EXTERNAL TRIGGER INPUT or when the MANUAL PUSHBUTTON is depressed.

   TRIG MODE - The carrier generator will stop running. The generator will run for one complete cycle from an external signal or each time the MANUAL PUSHBUTTON is depressed.

   PULSE MODE - The PULSE MODE is similar to the TRIG MODE above. The AM/FM Generator will trig the carrier generator "ON" for one complete cycle at the AM/FM Generator rate.

   BURST MODE - The AM/FM Generator is connected internally to gate the carrier generator "ON" and "OFF" at the AM/FM Generator rate.

   FM MODE - The AM/FM Generator will frequency modulate the carrier generator internally when in the FM MODE.

6. FM/BURST WIDTH - Provides adjustment of the FM (sweep) width when in the FM MODE and burst width in the BURST MODE.

7. CARRIER SWITCH - Selects the desired carrier or output waveform desired. The EXT position allows the use of an external carrier or waveform.

8. AMPLITUDE - Provides $>$ 20db variable attenuation of the output signal. Amplitude control has no effect on carrier level or AM level adjustment.

FRONT PANEL FAMILIARITY (Figure 2.1.1) Continued

9. DC OFFSET - When switched on, provides variable control of the D.C. level of the output waveform.

10. AM SWITCH - Allows amplitude modulation of the selected carrier waveform.

11. CARRIER LEVEL - When in the AM MODE, this control provides complete adjustment of the Carrier Amplitude from Max Pos through 'Null' to Max 'Neg'. 180° phase shift occurs from Max + to Max - setting. May be utilized as a variable phase control.

12. AM LEVEL - This control adjusts the amount of AM signal applied to the modulator. The desired amount of modulation is adjusted by means of the CARRIER LEVEL and/or the AM LEVEL controls.

13. AM/FM RANGE - Selects the desired frequency range of the AM/FM generator.

14. 100:1 VARIABLE - Provides variable adjustment of AM/FM frequency between fixed ranges.

    This control allows adjustment over a two decade range or 100:1.

15. AM/FM FUNCTION - A SQUARE, TRIANGLE, or SINE WAVEFORM may be selected to amplitude modulate the carrier waveform selected by the CARRIER SWITCH.

    Symultaneous AM/FM may be obtained by placing the MODE SWITCH to FM and the AM switch ON.

    The selected waveform from the AM/FM FUNCTION SWITCH will AM and/or FM the carrier signal selected.

    FM width, AM level, and CARRIER level are all independent of each other.

16. EXTERNAL AM INPUT - When in the AM Mode, an external signal may be used to AM the Carrier Waveform selected. The AM level must be set to min. to avoid mixing of the internal and external AM signals, unless mixing is desirable.

17. OUTPUT - BNC output connector providing 50Ω output impedance for connection to external equipment.

18. ATTENUATOR - A pushbutton attenuator providing a 10, 20, and 30db PAD for a total attenuation of 60db in 10db steps.

19. EXTERNAL CARRIER INPUT- An external carrier or signal may be used when the CARRIER SWITCH is in the EXT position. Amplitude modulation of this external waveform is easily accomplished utilizing the AM/FM Generator.

FRONT PANEL FAMILIARITY (Figure 2.1.1) continued.

20. SYNC OUT - Provides a SQUARE WAVE for syncronizing external equipment to the Carrier Generator.

21. MANUAL PUSHBUTTON - The MANUAL PUSHBUTTON allows manual gating and triggering of the Carrier Generator in the GATE and TRIG MODE of operation.

22. EXTERNAL FM INPUT - Provides external control of frequency for FM, sweeping, frequency shift keying, D.C. frequency control, etc.

23. EXTERNAL TRIGGER INPUT - When in the GATE and TRIG MODE, the Carrier Generator may be externally gated or triggered by application of an external signal at the EXTERNAL TRIGGER INPUT.

24. AM/FM SYNC OUTPUT - Provides a square wave for syncronizing external equipment to the AM/FM Generator.

25. AM AUX OUTPUT - Provides monitor of the AM generator and an output connection for the internal modulating generator waveform.

2.2.0 FIRST TIME OPERATION

NOTE: Before applying power to the instrument, the input power line switch must be in the proper position corresponding to the line voltage source which will be applied. The instrument comes supplied with the proper fuse for 117V operation. If the unit is to be operated from 230V AC line, place the line switch located on the rear panel to the 230V position and change the fuse as indicated by the fuse data silkscreened on the rear panel.

Plug the power cord into the proper source of 117V AC or 230V AC 50-400Hz and turn on the power switch.

NOTE: It is recommended that the rear panel chassis ground and circuit ground be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

Set controls as follows:

RANGE	10K
MULTIPLIER	1.0
MODE	RUN
FUNCTION	∿
AMPLITUDE	MAX
ATTENUATOR	0db (OFF)
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

FIRST TIME OPERATION (Continued)

1. Connect the main output through a 50Ω coaxial cable into a 50Ω terminator to a suitable oscilloscope. A 10KHz 10V P-P triangle waveform should be observed under these conditions.

2. Switch the Function switch through its various output waveforms.

3. The frequency may be selected by the Range switch and/or the Multiplier dial.

4. Switch the D.C. Offset switch ON and observe the waveform D.C. level may be adjusted as desired.

   NOTE: Reduce output amplitude while changing D.C. offset to prevent saturation of waveform.

5. Observe the output amplitude can be adjusted over its 80db of dynamic range by the Amplitude vernier and the pushbutton attenuator.

GATE MODE

6. Place the Mode switch in the Gate position. Observe the main generator is now locked out. Observe the output while depressing the Manual pushbutton. The generator will free run as long as the pushbutton is depressed.

7. Rotate the Start Level control and observe the lockout level may be adjusted to the desired level or phase.

NOTE: The generator will free run if the Start Level is rotated too far (90 degree phase shift).

TRIG MODE

8. Set the Main Mode switch to the Trig position. Observe one complete cycle each time the Manual pushbutton is depressed.

PULSE MODE

9. Set the Mode switch to Pulse.

   Set controls as follows:

FUNCTION	SQUARE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2 ms/cm

FIRST TIME OPERATION (Continued)

Trigger scope from rear panel AM/FM Sync output.

The generator is now being triggered by the AM/FM Generator, providing a pulse output.

Observe that the carrier generator Range and Multiplier controls vary the pulse width. The repetition rate is variable by varying the AM/FM frequency.

BURST MODE

10. Place the Mode switch to Burst. The main generator is now being gated by the AM/FM Generator, producing a burst (more than one cycle) at the output.

Set the generator controls as follows:

FUNCTION	SINE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPEq	2 ms/cm

Trigger the scope from AM/FM Sync output on rear panel.

Observe by adjusting the FM/Burst width and AM/FM frequency the burst "on" and "off" time may be varied. The frequency of the main generator determines the frequency of each cycle in the Burst.

FM MODE

11. In the FM Mode, the AM/FM source is connected to the FM input internally via the FM/Burst width potentiometer.

Set controls as follows:

MODE	FM
RANGE	10K
MULTIPLIER	.10
CARRIER	TRI
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	100Hz
100:1 VAR	FULL CCW (1Hz)
FM/BURST WIDTH	MID RANGE
AM/FM FUNCTION	

FIRST TIME OPERATION (Continued)

Observe the main generator triangle is being swept about the center frequency 1KHz.

Observe the FM width change while adjusting the FM/Burst width control.

Observe the FM sweep rate change while adjusting the AM/FM frequency.

AM MODE

12. Amplitude Modulation

Set controls as follows:

RANGE	100K
MULTIPLIER	1.0
CARRIER	∿
AMPLITUDE	MAX
D.C. OFFSET	OFF
MODE	RUN
AM/FM RANGE	10K
100:1 VAR	CAL
AM LEVEL	MAX
AM	ON
AM/FM FUNCTION	∿

100%:

Connect an oscilloscope to the output. Trigger the oscilloscope from the AM/FM sync output on the rear panel.

Adjust the Carrier level until 100% modulation is obtained.

Select TRI and SQ with the AM/FM Function switch and observe the carrier modulation corresponding to the waveform selected.

SUPPRESSED CARRIER

Set the AM level to min. Adjust the carrier level for a Null at the output.

AM/FM Function to ∿

Set the AM Level to Max and observe suppressed carrier Modulation.

SECTION 3

CIRCUIT DESCRIPTION

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

MAIN GENERATOR

The Summing Amplifier sums the currents from the Multiplier dial, VCF input and internal sweep signal. The output of the Summing Amplifier drives the Positive and Negative current sources. A diode gate alternately connects the Positive and Negative constant current sources to the timing capacitor selected by the Range switch. This constant current charging and discharging the timing capacitors produces the required triangle. The Tri Buffer supplies the power to drive the associated circuitry without loading the current sources. Switching signal for the Diode Gate is supplied from the Bi-Stable switch in conjunction with the Level Detector. The Sync signal from the Level Detector and Bi-Stable switch is brought out through the Sync Output Buffer to prevent loading of the Bi-Stable switch.

The Lockout current source sinks the timing current from the current source during Gate, Trigger, Pulse and Burst Modes. Logic for these modes is obtained from the Main Generator Lockout Amplifier. The Reset Buffer supplies a signal from the Level Detector- Bi-Stable switch, needed for completion of last cycle and reset for the Logic Gate.

D.C. coupled gating and triggering is accomplished by the Trig Level Comparator. Signal from the Trig Level Comparator enables the Lockout Logic Gate during lockout modes. The Manual Gate and Trig switch serves to eliminate contact bounce of the Manual Pushbutton switch during manual triggering and gating to prevent multiple triggering. The triangle from the Tri Buffer is shaped by the Sine Converter and amplified by the Sine Amplifier to produce the sine-wave.

All output waveforms pass through the Input Buffer and are then connected to the Output Amplifier. The Output Amplifier provides the necessary power to drive the Main Output. The pushbutton Output Attenuator provides 60db of attenuation in 10db steps.

AM/FM GENERATOR

The AM/FM Generator loop consists of an integrator and a level detector. This loop produces the square and triangle waveform for internal gating, pulsing, FM and AM. The Sync Buffer provides a square wave sync pulse for synchronizing external equipment to the AM/FM Generator.

AM MODULATOR

The Am Modulator provides amplitude modulation of the carrier waveform selected by the Carrier Switch. The Am signal may be selected by the AM/FM Function switch. The Square switch produces the required square wave for the modulator from the AM/FM Level Detector. The Triangle from the AM/FM integrator is level shifted in the Tri level Shift Amplifier. It is used to AM and FM the

3.1.0 BLOCK DIAGRAM (Figure 3.1.1) Continued

Carrier Generator. The tri from the Level Shift Amplifier is converted to a sine wave by the sine converter providing the third waveform to be used for AM and FM.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

Line voltage is connected to transformer T100 through S101, a line voltage switch. This switch selects either the 117V or the 230V tap on the transformer. Full wave rectification is accomplished by D100 from the center tapped secondary. C101 and C102 provide ±23V filtering.

+12V SUPPLY

Q100 is a precision voltage regulator. The output is connected to a series pass driver Q110 which supplies the necessary current for the +12V supply. The reference divider, R111, R112 and R113, is connected across the +12V supply. R112 adjusts the reference to the voltage regulator, establishing +12V at the output. Q100 is short circuit protected internally. Q100, pin 10, senses the output current through R110 and will turn off the +12V supply in the event of a short circuit of 500ma.

-12V SUPPLY

Q135 is an operational amplifier. The +12V is connected through R114 and -12V adjust R115 to the inverting input (pin 2). The output of Q135 is offset by Zener Diode D135 to keep the operational amplifier output level within safe limits. Q130 is an emitter follower which drives the series pass transistor (Q125). Feedback resistor R120 establishes the proper amount of negative feedback. Q120 senses the output current through R121 providing short circuit limiting at about 500ma.

+5V SUPPLY

The +5V supply is simply an emitter follower. R141 and R140 provide approximately +5.6V at Q150 base, establishing +5V at the emitter.

-7V SUPPLY

The -7V supply is also an emitter follower. R161 and R160 provide approximately -7.6V at Q170 base, establishing -7V at Q170 emitter.

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2)

Q200 is an operational amplifier connected for a voltage gain of -1. The Main Multiplier dial (S200) forms a Kelvin-Varley Voltage Divider providing approximately

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2) Continued

+5V to +.5V to the Summing Amplifier Input (TP209). By varying the applied input voltage, the signal to the Constant Current Source Drivers can be varied thus providing a method for changing the timing current and thus the frequency. The Summing Amplifier inverts the applied input voltage. When S200 (Mult) is in the Search Mode, the vernier (R210) is connected between +12V and ground to supply a 1000:1 voltage ratio, thus a 1000:1 frequency deviation. Main Timing Adjust (R207) establishes the correct input voltage to the Kelvin-Varley Divider to obtain the correct timing during calibration. D200 and D201 provide input protection for the μ A709 operational amplifier. R201 (1000:1 Adj) provides input current to Q200 to adjust the 1000:1 range when the multiplier is in search.

The FM Input is connected to the Summing Amplifier at TP205, providing an external source of frequency control. By applying voltage at the FM input, the frequency may be varied as with the Multiplier dial. The applied input voltage will add to or subtract from that established by the Multiplier dial setting. If the Multiplier dial is set at position 1.0, approximately +5V is applied to the input of the Summing Amplifier. If a positive voltage is now applied to the FM Input Jack, the Summing Amplifier will saturate. If -5V is applied at the FM Input this will add to the +5V applied by the Multiplier dial and the resultant input voltage will approach OV, driving the Summing Amplifier output to approximately 1/1000 of the frequency of the Range and Multiplier setting. If the Multiplier dial were in the Search Mode of operation and set at approximately 0V at TP209 by the Search vernier (R210), the frequency would be approximately 1/1000 of the Range setting. By applying +5V at the FM Input, the two voltages will sum, establishing approximately +5V at the Summing Amplifier input. This will cause the frequency to sweep up to approximately the frequency of the Range setting.

TP204 is the internal FM input, connected to the AM/FM Generator when in the FM Mode of operation. The desired waveform may be selected by the AM/FM Function switch.

The FM/Burst width potentiometer R502 FIG. 6.2.4 allows the amount of FM to be set as desired. The Center Frequency is set by the Range and Multiplier switch.

All three FM waveforms are bi-polor and will FM the carrier about the Center Frequency set by the Range and Multiplier switch.

NOTE: The FM width is capable of 1000:1 frequency ratio. If the Multiplier is set at 1.0 and the Range is set at 10KHz, the generator will only sweep up to approximately 11KHz, the current sources will saturate and slightly distort the output waveform until the FM signal drives the current sources below 11KHz. Below 11KHz, the current sources are again within their operating range.

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2) Continued

The current source will then FM the carrier down in frequency to below 10Hz with sufficient FM signal applied.

To obtain the best results, set the center frequency using the range and Multiplier controls and adjust the FM Width until the correct upper and lower frequency limits are obtained.

The VCF Balance (R229) compensates for the input offset voltage of the Summing Amplifier Q200. The output range of the Summing Amplifier is approximately 0V to -5V and drives the Positive and Negative Current Source Drivers.

POSITIVE AND NEGATIVE CURRENT SOURCE DRIVERS

The output of the Summing Amplifier (0V to -5V) is connected to Q240, the Positive Current Source Driver, through R260B. Q255 and Q240 provide a constant current source in the feedback loop of the Positive Current Source Driver. Q240 will turn on Q255 until a feedback current equal to the input current through R260B is equalized. This current causes a voltage drop across R255A which equals the voltage drop across R260B.

The Search Sym Adj (R242) compensates for offset in the operational amplifier, establishing a 0V reference at Q240 input and balancing the two Current Source Drivers at 1000:1 to obtain correct symmetry at 1000:1.

Q250 in conjunction with Q260 make up the Negative Current Source Driver. The output signal from Q200 Summing Amplifier is connected to Q250 operational amplifier at the Non-Inverting Input. Q250 is connected as a voltage follower. Q260 establishes a constant current equal to the input voltage ÷ R260A. This constant current causes a voltage drop equal to the output voltage of the Summing Amplifier, across R255B, exactly equal to and of opposite polarity of that across R255A.

POSITIVE AND NEGATIVE CONSTANT CURRENT SOURCE.

Q275, Q280, Q285, and Q290 are the Positive and Negative Constant Current Sources providing the constant timing current to charge and discharge the timing capacitor. Q275 operational amplifier and Q280 FET are connected to form a constant current source.

The signal across R255A is connected to Q275 operational amplifier at the non-inverting input. This causes a voltage of exactly the same polarity and amplitude across R276A timing resistor. This causes a constant current E(R276A) ÷ R(R276A) to charge the timing capacitor when the Diode Gate is turned on, connecting the Positive Current Source. The FET (Q280) prevents loading of the current sources at very low timing currents (1000:1).

3.2.2 POSITIVE AND NEGATIVE CONSTANT CURRENT SOURCE (Continued)

Q285 operational amplifier and Q290 FET provide the negative constant current needed to charge the timing capacitor in exactly the same way. The 0.1Hz symmetry (R292) compensates for offset current in the operational amplifiers (Q285 and Q290) to establish the correct symmetry on slow timing ranges with large timing resistors. This adjustment is made on the 1Hz range at the .1 setting on the Multiplier Dial.

The Diode Gate is made up of D280, D281, D282 and D283. The timing capacitors are connected at TP330 through the Range Switch, which also switches the Timing resistors.

Gate switching signal is connected at D280 and D282 junction. When the Gate signal is positive, D282 is forward biased and sinks the timing current from the Negative Current Source, thus disconnecting the Negative Current Source. D280 is now reverse biased, allowing timing current to charge the timing capacitor through D281 from the Positive Current Source. When the Gate signal switches negative, D280 is forward biased, thus sinking the positive timing current through D280. D282 is now reverse biased, allowing timing current to charge the timing capacitor from the Negative Current Source through D283. D301 is connected to the Lockout Current Source and sinks the timing current during lockout.

TRIANGLE BUFFER

Q330A and B and Q340A and B serve as a unity gain, high input impedance buffer for the triangle generated at TP330. Q330A FET prevents loading of the current sources by its very high input impedance. Q330A is a source follower driving Q340A, an emitter follower. Q340B provides offset and temperature compensation for Q340A while Q330B provides offset and temperature compensation for Q330A.

LOCKOUT CURRENT SOURCE

The lockout current source consists of Q265 (operational amplifier) and Q270 (FET) connected as a current source. The lockout current source and the positive current source are both driven by the positive current source driver Q240 and Q255 R300, R301 and R302 provide twice the current as the positive and negative current source.

In the Run mode, D525 is forward biased and sinks the lockout current from the lockout current source, and reverse biases D300 and D301. During lockout, D525 is reverse biased. D300 connected to the start level amplifier will sink all the current from the lockout current source. When the timing capacitor charges negative, D301 will become forward biased when the timing capacitor reaches the voltage level established by the start level control D306 at D300 cathode. The timing capacitor will stop charging when D301 becomes forward biased and sinks the timing current from the negative current source. D300 will sink exactly the same current as D301. The current thru D300 and D301 will always be the same because the lockout current source supplies twice the timing current as the negative current source.

3.2.2 LOCKOUT CURRENT SOURCE (Continued)

START LEVEL AMPLIFIER

The start level amplifier is a closed loop operational amplifier (Q300) with a gain slightly $< 1/10$. Q320 and Q325 buffer provides a very low output impedance necessary to drive lockout diode (D300). The output of the buffer will swing approximately ±1.4V depending upon the setting of the start level control R306. This setting determines the level at which the triangle will lock out.

3.2.3 LEVEL DETECTOR/BISTABLE SWITCH (Figure 6.2.3)

Level Detector/Bistable Switch Q400A, B, C is a differential amplifier used as a level detector. Q400C is a constant current source for differential amplifier Q400A and Q400B. The reference level at the base of Q400B is determined by one of the current sources connected by the diode gate, D403 -D406. D400 and D401 limit the collector swing of the differential amplifier to improve high frequency response. The Level Detector collectors drive a non-saturating current mode switch. The Bistable Switch is differential input and differential output. One output, Q430, Q435, drives the reference gate for the Level Detector, the Reset Buffer, the Sync Output Buffer and the Current Source Gate. R402 and R409 adjust the positive and negative trip points of the Level Detector, establishing the positive and negative peaks of the triangle. The other output, Q440, Q445 provides the square wave signals for the Output Amplifiers. The Norm Sq. Amp (TP459) is adjusted by R456 (+sq. amp) and R461 (-sq. amp). The Neg. Sq. Amp (TP464) is adjusted by R463 (neg. sq. amp). Q430 and Q435 provide the Pos. Sq. at TP458. The Pos. Sq. Amp is adjusted by R450 (pos. sq. amp).

SYNC OUTPUT BUFFER

Q450 is an emitter follower which provides isolation while providing a sync pulse to the Sync Output Jack. The sync pulse is clipped by diodes D450 through D453.

3.2.4 LOCKOUT LOGIC (Figure 6.2.4)

TRIGGER LEVEL COMPARATOR

Q500 is a high speed differential comparator providing D.C. coupled Triggering, Gating and Bursting modes for the Main Generator Logic Gate.

Run Mode:

In the Run mode, +12V is applied to the inverting input of Q500 through S500A. This assures that the non-inverting input always remains more negative than the inverting input. This causes Q500 output to remain negative or in the Run Mode of operation. The input of the comparator is protected by clamping diodes D500 and D501.

3.2.4 LOCKOUT LOGIC, Trigger Level Comparator (Figure 6.2.4) Continued

Gate Mode:

In the Gate mode, the +12V from S500A is disconnected, causing Q500 inverting input (pin 3) to go to a more negative state than the non-inverting input due to R509. This switches the output of the comparator to its positive or "1" state. The "1" from the comparator placed the Logic Gate in a lockout condition. The generator will remain in a lockout condition until signal is received at the comparator input (pin 2).

In the Gate mode the comparator input is connected through S500B to the External Trigger Input. A signal 1.2V will cause the Trigger Level Comparator to switch, placing the Logic Gate in a "run" condition. When the input signal is removed or falls below 1.2V, the comparator will allow the Logic Gate to return to its lockout condition.

Trigger Mode:

The only difference between the Gate and Trigger modes of operation is that the output of the comparator is AC coupled to the logic Gate instead of DC coupled. When the trigger signal causes the comparator to switch, the negative output of the comparator AC couples a differentiated negative pulse into the Logic Gate, placing it in a "run" condition. The duration of this pulse is very short, allowing the Logic Gate input to return to a "1" or a lockout condition even though the comparator may still be "OFF" in its negative state. The square wave from the level detector (R454) will couple a "0" into the Logic Gate upon completion of the first cycle and cause the generator to lock out. The external trigger signal must be removed, allowing the comparator to reset before another pulse can be coupled into the Logic Gate. One complete cycle will be generated each time a signal 1.2V is applied at the Trigger Input.

Pulse Mode:

In the Pulse Mode of operation the square wave from the AM/FM Sync Buffer is connected to the trigger comparator at TP503. The AM/FM generator will cause the carrier generator to run one cycle for each positive going edge of the AM/FM generator signal.

NOTE: The carrier generator frequency must be greater than the AM/FM generator frequency to prevent erratic pulsing of the carrier generator.

Burst Mode:

The Burst Mode functions as in the Gate Mode. The desired waveform is selected from the AM/FM function switch. The waveform selected is connected to R502 the FM/Burst width potentiometer. The Burst width potentiometer allows attenuation of the signal applied to the trigger comparator. By adjusting the amount of signal to the comparator, the duty cycle of Burst width may be adjusted.

3.2.4. LOCKOUT LOGIC, Trigger, Level Comparator (Continued)

If the square wave is selected for Burst, the duty cycle will not be adjustable by the Burst width potentiometer.

NOTE: When the Burst width period approaches the period of one cycle of the carrier generator, the generator will lock out until the Burst width is adjusted greater than the period of one cycle of the carrier generator.

FM Mode:

In the FM mode, the carrier generator is placed in a "Run" condition by the +12V at S500A. All trigger signal input paths are disconnected. The waveform selected for FM is connected to the FM input (R204) through the FM/Burst width potentiometer R502. The FM or sweep width may be adjusted as desired with the FM/Burst width. The carrier generator will sweep about the center frequency set by the Range and Multiplier.

MANUAL GATE/TRIGGER SWITCH

The Manual Pushbutton switch located on the front panel is used in conjunction with the Manual Trigger Logic Switch to provide a bounce-free switch for manually gating and triggering the Main Generator. Q520C and D are one-half of a Quadruple 2 Input Positive Nand Gate. Normally S520, the Manual Pushbutton, keeps one input of the Nand Gate, pin 9, at "0" and pins 8 and 12 at "1". Pin 13 is connected to +5V or a "1" through R521. With both inputs of Q520D positive the output (pin 11) will remain at "0". The output of this Positive Nand Gate is connected through R508 to the Trigger Level Comparator. When S520, the Manual Pushbutton, is depressed, pin 13 of Q520D will be set to "0". This will cause the output (pin 11) to go to a "1" or positive state. This "1" is coupled through R508 to the Trigger Level Comparator Input. This "1" will remain until the Manual Pushbutton is released, allowing the output of Q520D to return to a "0".

MAIN GENERATOR LOCKOUT LOGIC GATE

Q520A and B is one-half of a Quadruple 2 Input Positive Nand Gate which provides the necessary logic function for the lockout amplifier Q525 and Q530 which operates as a switch. In the Run mode of operation, the trigger level comparator applies a "0" at the input of Q520A pin 1. As long as this "0" is present, the output of Q520A (pin 3) will remain positive ("1"). This positive signal will cause the lockout amplifier to remain in a "run" condition. In the Gate mode of operation, the trigger level comparator supplies a "1" to the logic input Q520A pin 1. The output will remain a "1" or in a "run" condition until a negative pulse ("0") is applied at Q520B pin 5 from the square wave. This negative pulse causes Q520B pin 6 to go to a "1" state which is connected to Q520A pin 2. Q520A output will now switch to a "0" causing the generator to lock out.

3.2.4 LOCKOUT LOGIC, Trigger level Comparator (Continued)

LOCKOUT AMPLIFIER

The lockout amplifier is a differential amplifier used as a Bi-polar switch. The output of Q525 provides ±1.8V to D525. D525 is forward biased in the Run mode of operation by Q525 collector (-1.8V) disabling the lockout current source. During lockout, Q525 is "off", reverse biasing D525 enabling the lockout current source.

3.2.5 SINE SHAPER AND AMPLIFIER CIRCUITS (Figure 6.2.5)

SINE CONVERTER

The Sine Converter converts the triangle to a sine by means of a bi-polar diode shaping network. The triangle is connected at TP602. R602 and R603 form a voltage divider to correctly match the triangle amplitude to the converter network. As the triangle rises positive, each diode gate will turn on in succession, causing the output of the network to form a sine wave at the junction of the three voltage dividers. The diode gates will turn on and off in sequence following the triangle Sine A, B, C and D potentiometers. Adjust the current thru each bridge for minimum distortion.

SINE AMPLIFIER

This sine wave is amplified by differential amplifier Q600A and B. Q600C is a constant current source for the input differential stage. Sine D.C. Adj (R625) compensates for offset in the input pair, establishing a 0V reference at the Sine Output. A second differential stage is driven by Q600A and B. The output across R636 is connected to the Output Buffer (Q645 and Q650) through an emitter follower (Q635). The output (TP645) is connected through feedback resistors R626 and Sine Amplifier adjustment R627 to the inverting input.

± SINE

R646, R647 forms a voltage divider to decrease the sine amplitude. R649 and R648 (± Sine D.C.) provides offset current to establish a negative reference for the ± Sine. C646 (± Sine Comp.) provides high frequency compensation for the ± Sine.

3.2.6 ATTENUATOR AND AMPLIFIER CIRCUITS (Figure 6.2.6)

INPUT BUFFER

The Input Buffer Q700, Q705 prevents loading from the low input impedance of the power amplifier.

3.2.6 ATTENUATOR AND AMPLIFIER CIRCUITS (Figure 6.2.6) Continued

AMP 1

S700 connects the various waveforms to the inverting input. Q701A and B are the input differential amplifier. Q700C is a constant current source for Q700A and B. The D.C. BAL (R723) compensates for offset of the input pair and the Input Buffer. The D.C. offset switch on the front panel supplies offset current to the non-inverting input for adjusting the D.C. reference at the output. Q725 and Q730 are a second differential stage driven by Q700A and B. The signal at Q730 is connected to the output through the output buffer, Q735 and Q740. R727 is selected to adjust the quiescent current in the output buffer to approximately 10ma. Gain is fixed by feedback resistors R731 and R704. Q745 is a current source for Q730 to improve slewing rate.

AM PREAMP

The Am preamp is the same amplifier as AMP 1 and is used to boost the current mode output of the modulator to a voltage sufficient to drive AMP 1.

OUTPUT ATTENUATORS

The Output Attenuator provides six fixed levels of attenuation at 50Ω output impedance. The three attenuators are connected to add providing 10db, 20db, 30db, 40db, 50db and 60db of attenuation in 10db steps.

3.2.7 AM AMPLIFIER

The Am Signal Amplifier (Q1000) is an operational amplifier used to interface the internal and external AM signals to the differential logarithmic voltage to current converter Q1060.

AM Switch S1001 connects either the square, triangle, or sine waveform selected by the AM/FM function switch (S1000) to the input of the Amplifier Q1000. (TP1008).

R1008 (TRI AMP) provides gain adjustment of the input amplifier Q1000. R1001 (AM BAL) compensates for input offset voltage of the operational amplifier Q1000.

External AM signal is connected to the amplifier at TP1000.

The Carrier Level potentiometer R1011 adjusts the output swing of the amplifier (Q1000).

R1013 (AMP BAL) balances the output D.C. to provide equal carrier levels at both ends of the Carrier Level Control.

3.2.7 AM AMPLIFIER (Continued)

Q1060 is a differential logarithmic current to voltage converter required for driving the signal input of the double balanced modulator. The reference voltage of the input differential amplifier is approximately -3.72V. When the carrier level potentiometer is set to the Null position, the output of Q1000 will be approximately the same level -3.72V.

In this balanced condition, collector current thru the two input transistors will be equal establishing a Null condition at the signal input of the modulator Q1060 pins 14,3 and 7,11. Q1065 is a constant current source for the input differential amplifier Q1060. Q1060C and D are connected as diodes which convert the linear differential signal current to a logarithmic output voltage.

R1061 LIN ADJ is used to balance the collector current in the output diodes Q1060C and D.

CARRIER VOLTAGE TO CURRENT CONVERTER

Q1090A and B is a differential amplifier used to convert the carrier signal to a differential logarithmic output voltage for driving the Modulator carrier input pins 1 and 4.

Q1085 is the constant current source for the differential amplifier Q1090A and B.

R1092 adjusts the D.C. level of the carrier to be equal at max + and max - carrier level.

R1102 provides amplitude adjustment of the carrier.

Modulator:

Q1080 is an integrated circuit double balanced modulator. It accepts a carrier signal at its carrier inputs (pins 4 and 1) and an AM signal at its signal inputs (pins 7 and 8).

When both inputs are balanced, there will be no output at TP1082. An unbalance in the signal input channel will cause an unbalance in the output level TP1082.

When a carrier signal is applied at the carrier inputs, pins 1 and 4, the carrier signal may be controlled by varying the amount of unbalance at the signal input channel by means of the carrier level potentiometer R1011. 180° phase shift takes place from max + thru Null to max - carrier level. By applying signal to the AM signal amplifier externally or internally from the AM/FM Function switch, the carrier may be amplitude modulated as desired.

R1080 (D.C. LEVEL) provides adjustment of the modulator output D.C. level.

3.2.7 AM AMPLIFIER (Continued)

SQUARE SWITCH

The Square wave from the AM/FM level detector is connected to the Square Switch at TP1111. Q1110 and Q1120 is a Buffer used to drive the switching bridge D1111, D1110, D1122 and D1121. The square wave from the buffer is approximately ±2V. When the square wave is positive, current from the negative supply is diverted thru R112 and D112. The voltage at TP1114 is then determined by the voltage divider R1115, R1114, D1110 and R1112. R1115 provides adjustment of the output level. When the square wave from the buffer switches negative, current from the positive supply is diverted thru R1122, D1122, R1114 and R1115. The output square wave is approximately ± .75V. The square wave is connected to the AM/FM Function switch S1000.

TRI LEVEL SHIFT

The triangle from the AM/FM integrator is connected to TP1021 the input to the triangle level shift amplifier. Q1020 is an operational amplifier. The closed loop gain is set by input resistor R1021 and feedback resistor R1024 and R1028. R1028 provides adjustment of the output amplitude. R1022 and R1023 provides adjustment of the output D.C. level and level shifting of the input triangle. The output (TP1027) is connected to the AM/FM function switch S1000.

SINE CONVERTER/SINE AMPLIFIER

The sine converter converts the triangle waveform to a sine wave by means of a bi-polor diode shaping network. The triangle is connected to the shaping network at TP1027. As the triangle rises positive, each diode gate will turn on in succession, forming a sine wave at the output ot the three voltage dividers R1039. The diode gates will turn on and off in sequence following the triangle. The sine wave is amplified by the sine amplifier Q1050. The gain of the closed loop amplifier is fixed by input summing resistor R1051 and feedback resistor R1056 and R1058. R1056 provides adjustment of the output amplitude and R1052 provides adjustment of the output D.C. level.

The output is connected to the AM/FM Function switch S1000.

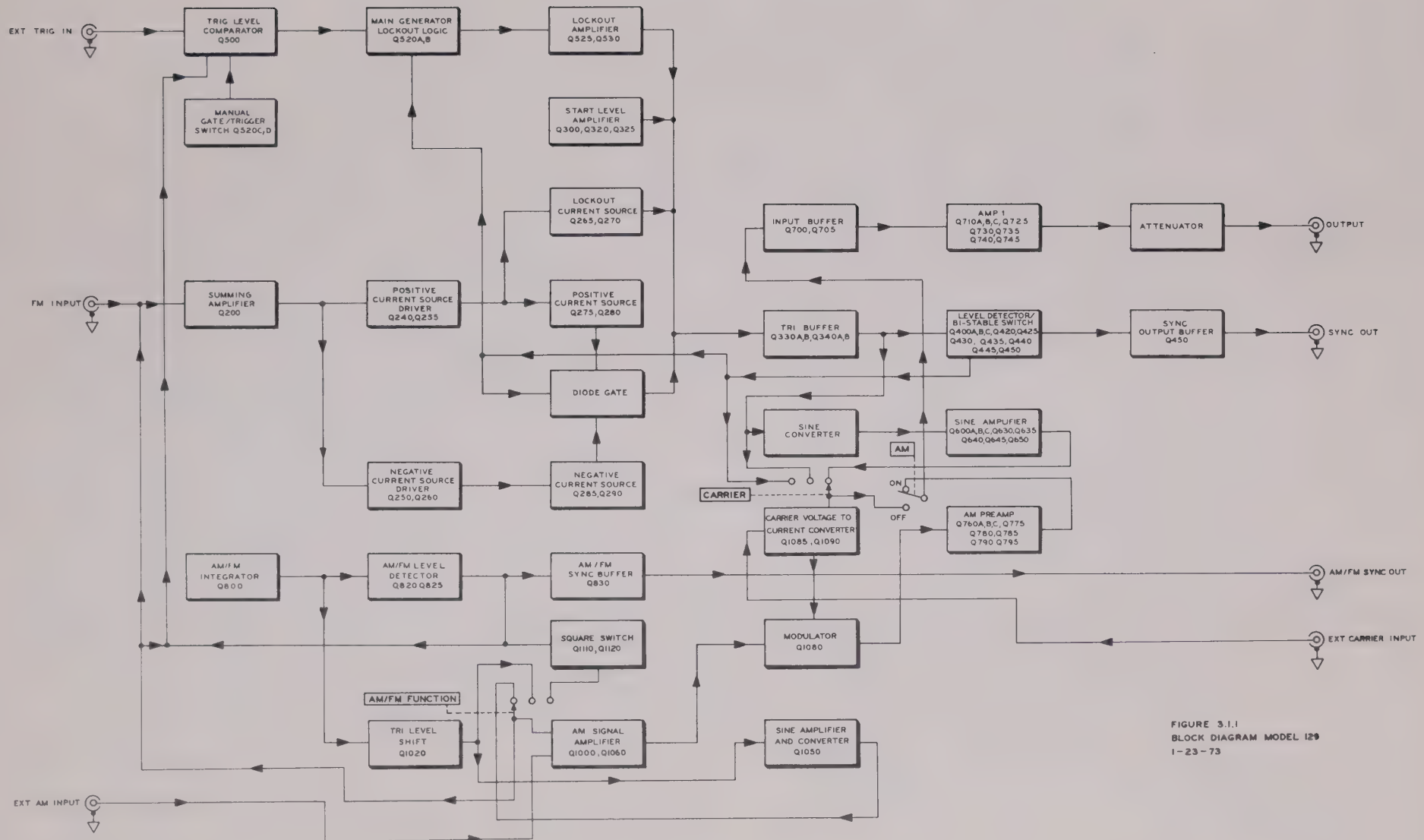


FIGURE 3.1.1
BLOCK DIAGRAM MODEL 129
1-23-73

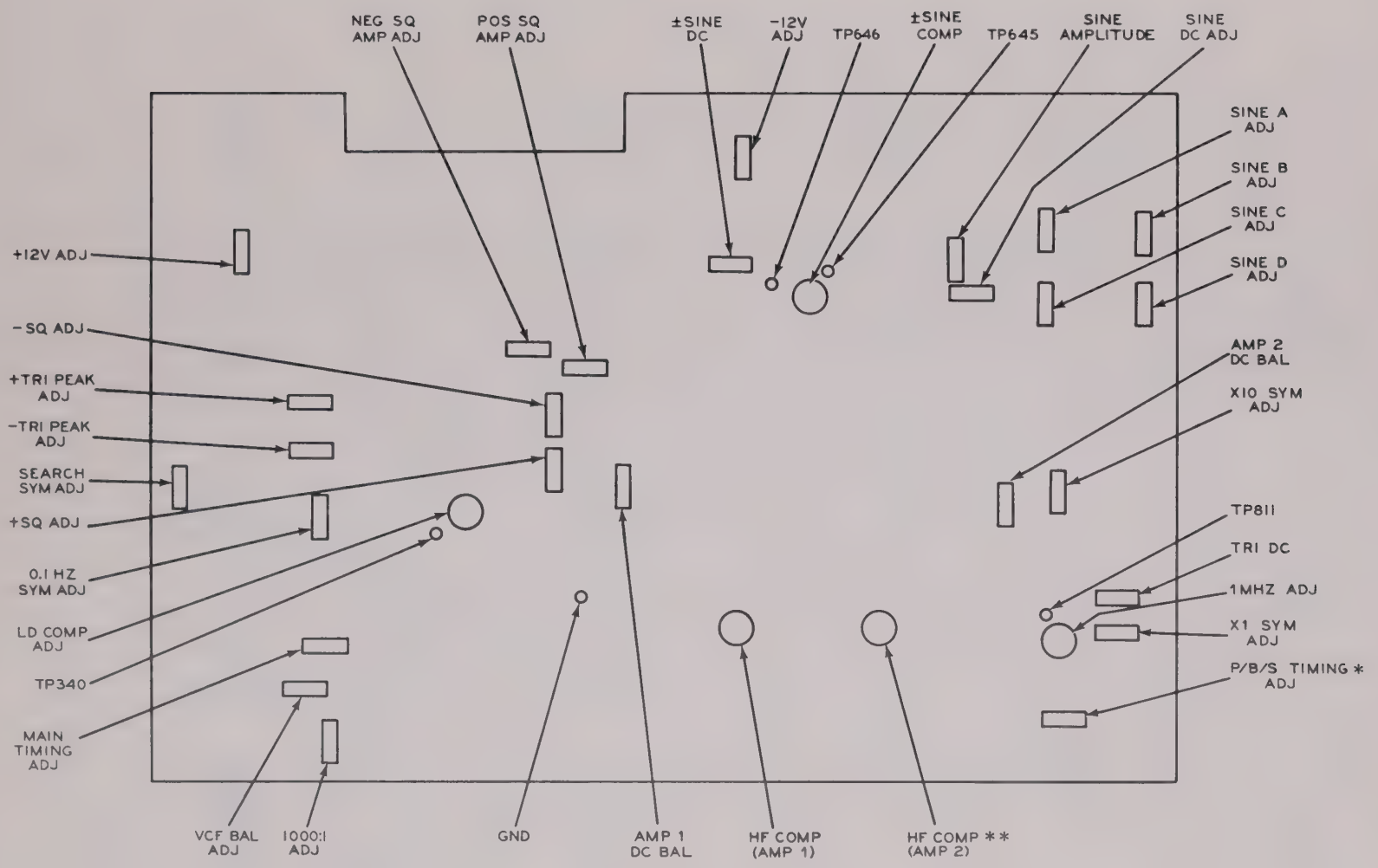
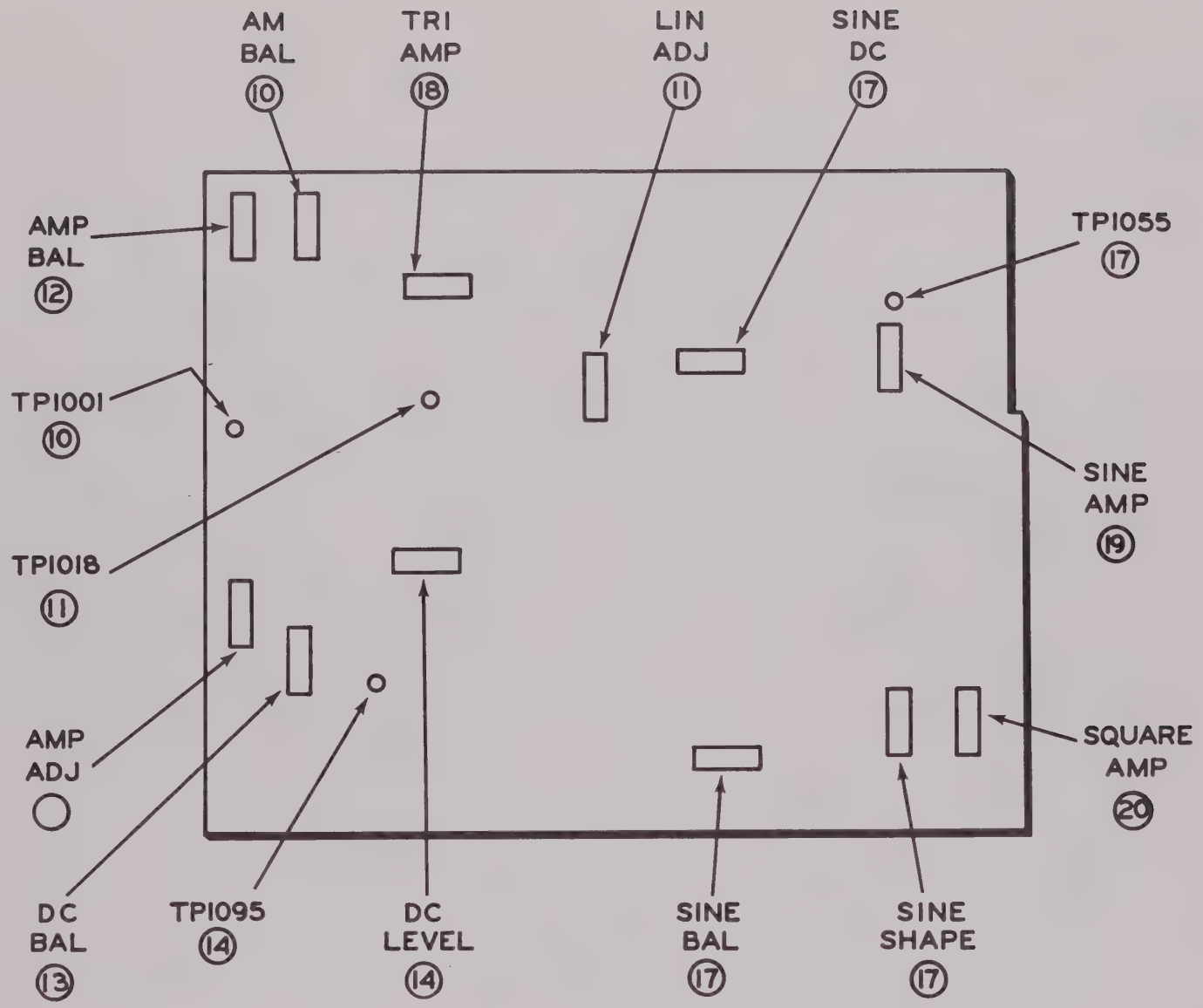


FIGURE 4.3.1
ADJUSTMENT LOCATION DETAIL
MODEL 124, 129

FOR MODEL 129
* AM/FM TIMING ADJ
** HF COMP (AM PREAMP)



○ INDICATES CALIBRATION SEQUENCE

FIGURE 4.3.2
ADJUSTMENT LOCATION DETAIL

SECTION 4

CALIBRATION

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2)

1. EQUIPMENT REQUIRED

The following test equipment or suitable equivalents of know accuracy are required for complete calibration of the Model 129 AM/FM Generator.

Oscilloscope - D.C. to 50 MHz. Differential plug-in with 10mv resolution
Distortion Analyzer---------.1% Residual Distortion
Frequency Counter/Time Interval Counter-----.1μ sec Time Base
Differential Voltmeter - 0.01% accuracy

2. INITIAL CONTROL SETTINGS

POWER SWITCH	ON
RANGE	1K
MULTIPLIER	1.0
MODE	RUN
CARRIER	∿
AMPLITUDE	MAX
ATTENUATOR	OFF
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VARIABLE	CAL
AM	OFF

3. MAIN GENERATOR (Figure 4.3.1)

+12 ADJUST

Connect voltmeter from +12V to ground. Adjust +12V adj for +12V ± 5mv.

-12V ADJUST

Connect voltmeter from -12V to ground. Adjust -12V Adj for -12V ± 5mv.

VCF BALANCE ADJUST

Set Multiplier .10. Connect frequency counter to Sync Out jack. Adjust VCF balance until there is no frequency shift on frequency counter when the FM input is grounded.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

3. MAIN GENERATOR (Figure 4.3.1) con't

± TRIANGLE PEAK ADJUST

Using differential plug-in, adjust +Tri Peak and -Tri Peak to obtain ±1.25V peak ± 10mv at TP340.

MAIN TIMING ADJUST

Set Multiplier 1.0. Adjust Main Timing to obtain 1KHz ± .5% at Sync Output jack as observed on frequency counter.

1000:1 ADJUST

Set Range to 100K, Multiplier to S.O. Max CCW. Monitor main output with oscilloscope and adjust 1000:1 Adj to obtain 100 Hz triangle as indicated on frequency counter.

SEARCH SYMMETRY ADJUST

Set Range to 100K, Multiplier to S.O. Max CCW. Monitor main output with oscilloscope and adjust Search Symmetry to obtain symmetrical waveform.

0.1Hz SYMMETRY ADJUST

Set Range to 1, Multiplier to .10. Connect time interval counter to the Sync Output jack and adjust 0.1Hz Sym for correct symmetry ± .5%.

Note: 0.1Hz Sym affects the -to+ half cycle.

Repeat 1000:1 Adjust, Search Symmetry and 0.1Hz sym adjustments.

LEVEL DETECTOR COMPENSATION

Monitor TP340 with oscilloscope. Connect oscilloscope probe GND lead to GND turret indicated on Figure 4.3.2. Set Mult to 1.0 Adjust L.D. Comp. (C401) for min amplitude change from 100KHz to 5 MHz.

5MHz TIMING ADJUST

Set Range to 5M, Multiplier to 1.0. Connect frequency counter to the sync Output jack. Adjust 5MHz trimmer mounted on Range switch to obtain 5MHz ± 1% on frequency counter.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

3. MAIN GENERATOR (Figure 4.3.1) con't

± SQUARE AMPLITUDE ADJUST

Set Carrier to Square. Set Range to 1K. Using differential plug-in, adjust +Square Amp and -Square Amp to obtain ± 1.25V peak ± 10mv square wave at TP459.

POSITIVE SQUARE AMPLITUDE ADJUST

Set Carrier to Negative Square. Adjust Positive Square Amp to obtain +1.25V peak ± 10mv at TP458.

NEGATIVE SQUARE AMPLITUDE ADJUST

Set Carrier to Positive Square. Adjust Negative Square Amp to obtain -1.25V peak ± 10mv at TP464.

OFFSET ADJUST

Set Carrier to ∿, Range to 1K, Multiplier to 1.0, Amplitude to Minimum (full CCW). Monitor output with oscilloscope and adjust Amp 1 D.C. Bal to obtain OV D.C. reference at output.

AMP 1 H.F. COMP. ADJUST

Set Range to 1M, Multiplier to 1.0, Carrier to Square, Amplitude to Maximum. Terminate the main output into 50Ω and monitor with oscilloscope. Adjust Amp 1 H.F. Comp. to obtain best looking SQ Wave with $<$ 50ns rise and fall time and $<$ 5% overshoot.

SINE A, B, C, D ADJUST

Set Range to 10K, Multiplier to 1.0, Carrier to Sine. Connect distortion analyzer to Output. Adjust Sine A, B, C and D and ± triangle peaks to obtain minimum sine distortion, typically less than 0.25%.

SINE AMPLITUDE, SINE D.C. ADJUST

Connect differential plug-in to TP645. Adjust Sine Amp and Sine D.C. to obtain ± 1.25V peak ± 10mv.

Repeat previous two steps due to interaction.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

3. MAIN GENERATOR (Figure 4.3.1) con't

± SINE D.C.

Set Carrier to +Sine; monitor TP646 with oscilloscope. Adjust ± Sine D.C. to obtain 0V reference ± 10mv at peak of sine.

± SINE COMP.

Monitor output with oscilloscope terminated into 50Ω. Adjust ± Sine Comp. for 0V reference on 5mHz frequency range.

4. AM/FM GENERATOR (Figure 4.3.2)

SET:

AM/FM RANGE	10K
100:1 VAR	CAL
AM	ON
AM LEVEL	MIN
OFFSET	OFF

5. X10 SYM

Connect time interval counter to AM/FM sync on rear panel. Adjust X10 sym to obtain symmetrical waveform as indicated on time counter.

6. X1 SYM

Set 100:1 VAR max CCW. Adjust X1 sym to obtain correct symmetry as indicated on time interval counter. Repeat X10 sym and X1 symmetry adjustments if necessary.

7. TRI D.C.

Set 100:1 Variable to CAL position monitor TP811 with oscilloscope and adjust Tri D.C. to obtain 0V reference at NEG peak of tri.

8. AM/FM TIMING ADJUST

Connect frequency counter to AM/FM sync output and adjust AM/FM timing adjust to obtain 10KHz ± 3%.

9. 1MHz ADJ

SET:

AM/FM RANGE	1M
100:1 VAR	CAL

Adjust 1MHz adjust to obtain 1MHz ± 3%.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

10. AM BALANCE (Figure 4.3.2)

Connect DVM from GND to TP1001. Adjust AM BAL to obtain 0V ± 5mv at TP1001.

11. LIN ADJUST (Figure 4.3.2)

Set: AM 'ON' and AM level min. Adjust carrier level on front panel to obtain -3.72V ± 20mV at TP1018. Connect oscilloscope to output and adjust Lin Adj for min output signal (NULL).

12. AMPLITUDE BAL (Figure 4.3.2)

SET:

RANGE	1K
MULT	1.0
CARRIER	∿
AMP	MAX
AM	ON

Connect DVM or oscilloscope to output and read AC volts. Adjust AMP Bal to obtain equal output voltage ± 50mv at max CW and max CCW setting of carrier level control.

13. D.C. BAL (Figure 4.3.2)

Connect VOM or oscilloscope to output and read D.C. level. Adjust D.C. Bal to obtain equal D.C. level of output waveform ± 50mv at Max CCW and Max CW setting of Carrier level control.

14. D.C. LEVEL (Figure 4.3.2)

Connect DVM to TP1095. Adjust D.C. level (Figure 4.3.2) to obtain -300mv.

15. AMP 2 D.C. BAL (Figure 4.3.1)

Monitor output with oscilloscope and adjust Amp 2 D.C. BAL to obtain OV D.C. level.

16. AMPLITUDE ADJUST (Figure 4.3.2)

SET: Carrier to ∿ and Carrier level to max CW position. Adjust Amp Adj to obtain equal output amplitudes when AM switch is switched on and off.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

17. SINE SHAPE AND SINE BAL (Figure 4.3.2)

SET:

AM/FM RANGE	10K
100:1 VAR	CAL

Connect a distortion analyzer from GND to TP 1055. Adjust Sine Shape and Sine Bal (Figure 4.3.2) to obtain min sine distortion (Typ < .5%).

Adjust Sine D.C. to obtain 0V D.C. level at TP1055.

18. TRI AMP (Figure 4.3.2)

Monitor the output with an oscilloscope (terminated into 50Ω).

SET:

RANGE	100K
MULT	1.0
CARRIER	∩∪
AM/FM FUNCTION	TRI
AMP	MAX

Adjust the Carrier level to obtain 1/2 of the Max pp output. Set AM level Max CW. Adjust Tri Amp to obtain 100% modulation.

19. SINE AMP - SINE D.C. (Figure 4.3.2)

Set AM/FM function to Sine. Adjust Sine Amp to obtain 100% modulation.

20. SQ AMP (Figure 4.3.2)

Set AM/FM Function to SQ. Adjust SQ Amp to obtain 100% modulation.

21. AM H.F. COMP:

SET:

RANGE	1M
MULT	1.0
CARRIER	⊓⊔
AMP	MAX
AM	ON
CARRIER LEVEL	MAX CW
AM LEVEL	MIN

Monitor the output with an oscilloscope terminated into 50Ω. Adjust Amp 2 H.F. Comp Fig (4.3.1) for best looking sq. wave with < 50 ns rise and fall time and < 5% overshoot.

SECTION 5

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidair Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. - Cardill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. - Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chasi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vaccline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	HI-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Arizona
04732	Fitron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05367	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst. Co.	Penacook, N.H.
06751	U.S. Semicon Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co, West Div.	Van Nuys, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Lab	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.,
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co., Phoenix Div	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09 34	Texas Capacitor Co.	Houston, Texas
09 45	Atahm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10597	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
.5203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
.5909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21835	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24655	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39583	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
47190	Muter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rawan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55076	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonewanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Talex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Trippett Electrical Inc.	Bluffton, Ohio
6 775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Osseo, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst./Div. Daystrom	Newark, N.J.
66295	Wiltek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71185	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
7 707	Cote Coil, Co., Inc.	Providence, R.I.
72354	John E Fast and Company	Chicago, Illinois
726 9	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72765	Girard-Hopkins	Oakland, Calif.
72825	Drake Mfg. Co.	Chicago, Illinois
72928	Hugh H. Eby, Inc.	Philadelphia, Pa.
72965	Gudeman Co.	Chicago, Illinois
72982	Robert M. Hadley Co.	Los Angeles, Calif.
73061	Erie Resistor Corp.	Erie, Pa.
73076	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	H. M. Harper Co.	Chicago, Illinois
	Helipot, Div. Beckman Instruments, Inc.	Fullarton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Phillips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George L. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. H. Winns and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littelfuse, Inc.	Des Plaines, Illinois
76005	Lora Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77368	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77073	Pacific Metals Co.	San Francisco, Calif.
77221	Proostran Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Pnaell Manufacturing Co.	Chicago, Illinois
77732	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bramer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80-30	Times Facsimile Corp.	New York, N.Y.
80 3.	Electronic Industries Assoc. Any and tube meeting EIA	Washington D.C. standards.
80207	Lorimar Switch, Div. of W L Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerland Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co, I	Norwalk, Conn.
81349	Military Specifications	
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Fisher Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83-86	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
8382	Loyd Scruggs Co.	Festus, Mo.
8417	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloamington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R.M. Bracamonte and Co.	San Francisco, Calif.
85660	Kailed Kards, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco
87664	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tower Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89731	Graybar Electric Co.	Oakland, Calif.
89462	Weldes Kahinoor, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	August Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gramor Mfg Co., Inc.	Wakefield. Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92-80	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Basset Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsulite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Monmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline-Von Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Comp. Div, Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtis-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allias Products Corp.	Miami, Flo.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.,
95354	Methode Mfg. Co.	Chicago, Illinois
95712	Doge Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	HI-Q Div. of Aerovox	Olean, N.Y.
96256	Thorarson-Meinsrom, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Rean Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gurdena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microsat, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	Genaral Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
995:5	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div, Controls Co. of America	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
B0100	PILOT LIGHT	1360045	71744
C0100	CAPACITOR, 100PF MICA	2810537	853
C0101	CAPACITOR, 2500MFD 35V	2900034	853
C0102	CAPACITOR, 2500MFD 35V	2900034	853
C0103	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0120	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0135	CAPACITOR, 470PF MICA	2810539	853
C0136	CAPACITOR, 22PF MICA	2810530	853
C0137	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0140	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0150	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0170	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0200	CAPACITOR, 220PF MICA	2810555	853
C0201	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0240	CAPACITOR, 220PF MICA	2810555	853
C0241	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0250	CAPACITOR, 220PF MICA	2810555	853
C0251	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0265	CAPACITOR, 220PF MICA	2810555	853
C0266	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0275	CAPACITOR, 220PF MICA	2810555	853
C0276	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0280	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0285	CAPACITOR, 220PF MICA	2810555	853
C0286	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0295	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0301	CAPACITOR, 220PF MICA	2810555	853
C0302	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0320	CAPACITOR, 22PF MICA	2810532	853
C0330	CAPACITOR, 8-50PF TRIM	2810022	72982
C0331	CAPACITOR, 150PF MICA	2810537	853
C0332	CAPACITOR, TIMING SET	2950004	10597
C0334	CAPACITOR, 47PF MICA	2810532	853
C0340	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0345	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0400	CAPACITOR, 47PF MICA	2810532	853
C0401	CAPACITOR, 8-50PF TRIM	2810022	72982
C0450	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0451	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0500	CAPACITOR, 68PF MICA	2810523	853
C0600	CAPACITOR, 100PF MICA	2810537	853
C0602	CAPACITOR, 120PF MICA	2810534	853
C0645	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0646	CAPACITOR, 8-50PF TRIM	2810022	72982
C0647	CAPACITOR, 47PF MICA	2810532	853
C0700	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0725	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0730	CAPACITOR, 0.001MFD 500V	2900018	37942
C0731	CAPACITOR, 3-12PF TRIM	2810036	72982
C0732	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0733	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0740	CAPACITOR, 220PF MICA	2810555	853
C0741	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0742	CAPACITOR, 68PF MICA	2810523	853
C0743	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0750	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0755	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0775	CAPACITOR, 3-12PF TRIM	2810036	72982
C0780	CAPACITOR, 220PF MICA	2810555	853
C0781	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0782	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0791	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0792	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0793	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0799	CAPACITOR, 68PF MICA	2810523	853
C0800	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0801	CAPACITOR, 100PF MICA	2810537	853
C0802	CAPACITOR, 0.01MFD 600V	2900019	37942
C0803	CAPACITOR, 1MFD 100V	2900022	84411
C0805	CAPACITOR, 39PF MICA	2810531	853
C0806	CAPACITOR, 5PF MICA	2810521	853
C0807	CAPACITOR, 3-12PF TRIM	2810036	72982
C0808	CAPACITOR, 39PF MICA	2810531	853
C0809	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0820	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0825	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1000	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1001	CAPACITOR, 39PF MICA	2810531	853
C1002	CAPACITOR, 39PF MICA	2810531	853
C1003	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1004	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1005	CAPACITOR, 5PF MICA	2810521	853
C1020	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1022	CAPACITOR, 39PF MICA	2810531	853
C1023	CAPACITOR, 39PF MICA	2810531	853
C1024	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1025	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1026	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1050	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1051	CAPACITOR, 39PF MICA	2810531	853
C1052	CAPACITOR, 39PF MICA	2810531	853
C1053	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C1080	CAPACITOR, 470PF MICA	2810539	853
C1090	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1091	CAPACITOR, 390PF MICA	2810556	853
C1092	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1093	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1094	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1102	CAPACITOR, 10PF MICA	2810529	853
C1110	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1111	RESISTOR, SELECTED VALUE		
C1120	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
D0100	RECTIFIER BRIDGE, MDA920A-3	1520922	4713
D0101	DIODE, 1N4001	1524001	1295
D0102	DIODE, 1N4001	1524001	1295
D0110	DIODE, 1N4001	1524001	1295
D0120	DIODE, 1N4001	1524001	1295
D0135	DIODE, 1N756	1520756	1295
D0200	DIODE, 1N914	1522914	7910
D0201	DIODE, 1N914	1522914	7910
D0280	DIODE, FD777	1520777	1295
D0281	DIODE, FD777	1520777	1295
D0282	DIODE, FD777	1520777	1295
D0283	DIODE, FD777	1520777	1295
D0300	DIODE, FD777	1520777	1295
D0301	DIODE, FD777	1520777	1295
D0322	DIODE, 1N914	1522914	7910
D0325	DIODE, 1N914	1522914	7910
D0400	DIODE, 1N914	1522914	7910
D0401	DIODE, 1N914	1522914	7910
D0402	DIODE, 1N914	1522914	7910
D0403	DIODE, FD777	1520777	1295
D0404	DIODE, FD777	1520777	1295
D0405	DIODE, FD777	1520777	1295
D0406	DIODE, FD777	1520777	1295
D0430	DIODE, 1N914	1522914	7910
D0435	DIODE, 1N914	1522914	7910
D0440	DIODE, 1N914	1522914	7910
D0445	DIODE, 1N914	1522914	7910
D0450	DIODE, 1N914	1522914	7910
D0451	DIODE, 1N914	1522914	7910
D0452	DIODE, 1N914	1522914	7910
D0453	DIODE, 1N914	1522914	7910
D0455	DIODE, FD777	1520777	1295
D0456	DIODE, FD777	1520777	1295
D0457	DIODE, FD777	1520777	1295
D0458	DIODE, FD777	1520777	1295
D0459	DIODE, FD777	1520777	1295
D0460	DIODE, FD777	1520777	1295
D0461	DIODE, FD777	1520777	1295
D0462	DIODE, FD777	1520777	1295
D0500	DIODE, 1N914	1522914	7910
D0501	DIODE, 1N914	1522914	7910
D0525	DIODE, FD777	1520777	1295
D0526	DIODE, 1N914	1522914	7910
D0527	DIODE, 1N914	1522914	7910
D0528	DIODE, 1N914	1522914	7910
D0600	DIODES, MATCHED SET FD777	1532777	10597
D0601	DIODES, MATCHED SET FD777	1532777	10597
D0602	DIODES, MATCHED SET FD777	1532777	10597
D0645	DIODE, 1N914	1522914	7910
D0650	DIODE, 1N914	1522914	7910
D0700	MATCHED DIODES, 1N914	1530003	10597
D0730	DIODE, 1N914	1522914	7910
D0731	DIODE, 1N914	1522914	7910
D0750	MATCHED DIODES, 1N914	1530003	10597
D0780	DIODE, 1N914	1522914	7910
D0781	DIODE, 1N914	1522914	7910
D0820	DIODE, 1N914	1522914	7910
D0821	DIODE, 1N914	1522914	7910
D0830	DIODE, 1N914	1522914	7910
D0831	DIODE, 1N914	1522914	7910
D0832	DIODE, 1N914	1522914	7910
D0833	DIODE, 1N914	1522914	7910
D1030	DIODE, 1N914	1522914	7910
D1031	DIODE, 1N914	1522914	7910
D1032	DIODE, 1N914	1522914	7910
D1033	DIODE, 1N914	1522914	7910
D1034	DIODE, 1N914	1522914	7910
D1035	DIODE, 1N914	1522914	7910
D1036	DIODE, 1N914	1522914	7910
D1037	DIODE, 1N914	1522914	7910
D1038	DIODE, 1N914	1522914	7910
D1039	DIODE, 1N914	1522914	7910
D1040	DIODE, 1N914	1522914	7910
D1041	DIODE, 1N914	1522914	7910
D1060	DIODE, 1N914	1522914	7910
D1080	DIODE, 1N914	1522914	7910
D1090	DIODE, 1N914	1522914	7910
D1091	DIODE, SELECTED	1530016	10597
D1110	DIODE, 1N914	1522914	7910
D1111	DIODE, 1N914	1522914	7910
D1112	DIODE, 1N914	1522914	7910
D1120	DIODE, 1N914	1522914	7910
D1121	DIODE, 1N914	1522914	7910
D1122	DIODE, 1N914	1522914	7910
F0100	FUSE, 3AG 1/2 AMP	1590015	71400
J0100	BINDING POST, BLACK	3550536	10597
J0101	BINDING POST, WHITE	3550535	10597
J0200	TO		
J0800	CONNECTOR, BNC	1310047	91836
J1000	CONNECTOR, BNC	1310047	91836
J1100	CONNECTOR, BNC	1310047	91836
Q0100	INTEGRATED CIRCUIT, UA723	1580012	7263
Q0110	TRANSISTOR, 2N4912	1564912	4713
Q0120	TRANSISTOR, 2N3643	1563643	4713
Q0125	TRANSISTOR, 2N4898	1564898	4713
Q0130	TRANSISTOR, 2N4121	1564121	7263
Q0135	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0150	TRANSISTOR, 2N2219	1562219	1295
Q0170	TRANSISTOR, 2N2925	1562925	1295
Q0220	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0240	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0245	TRANSISTOR, MPS3640	1563640	4713
Q0250	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0255	TRANSISTOR, 2N5485	1565485	4713
Q0260	TRANSISTOR, 2N4250	1564250	7263
Q0265	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0270	TRANSISTOR, 2N4250	1564250	7263
Q0275	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0280	TRANSISTOR, 2N5462	1565462	4713
Q0285	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0290	TRANSISTOR, 2N5485	1565485	4713
Q0300	OPERATIONAL AMPLIFIER, UA709	1580016	7263
Q0320	TRANSISTOR, 2N2219	1562219	1295
Q0325	TRANSISTOR, 2N2925	1562925	1295
Q0330	TRANSISTORS, MATCHED 2N5485	1575485	10597
Q0340	TRANSISTORS, MATCHED PAIR MPS3646	1570028	10597
Q0400	INTEGRATED CIRCUIT, CA3018	1580029	2745
Q0420	TRANSISTOR, MPS3640	1563640	4713
Q0430	TRANSISTOR, MPS3646	1563646	4713
Q0435	TRANSISTOR, MPS3640	1563640	4713
Q0440	TRANSISTOR, MPS3646	1563646	4713
Q0445	TRANSISTOR, MPS3640	1563640	4713

PART	DESCRIPTION	EXACT NO	MFG
Q0450	TRANSISTOR, 2N4121	1564121	7263
Q0500	INTEGRATED CIRCUIT, UA710C	1580020	7263
Q0520	INTEGRATED CIRCUIT, SN7400N	1580011	1295
Q0525	TRANSISTOR, MPS3640	1563640	4713
Q0530	TRANSISTOR, MPS3640	1563640	4713
Q0600	INTEGRATED CIRCUIT, CA3018	1580029	2735
Q0630	TRANSISTOR, MPS3640	1563640	4713
Q0635	TRANSISTOR, MPS3640	1563640	4713
Q0640	TRANSISTOR, MPS3646	1563646	4713
Q0645	TRANSISTOR, MPS3646	1563646	4713
Q0650	TRANSISTOR, MPS3640	1563640	4713
Q0700	TRANS, MATCHED 2N2905 & 2N2219	1572007	12597
Q0710	INTEGRATED CIRCUIT, CA3018	1580029	2735
Q0725	TRANSISTOR, 2N2905	1562905	1295
Q0730	TRANSISTOR, 2N2905	1562905	1295
Q0735	TRANSISTOR, 2N2219	1562219	1295
Q0740	TRANSISTOR, 2N2905	1562905	1295
Q0745	TRANSISTOR, 2N2219	1562219	1295
Q0750	TRANS, MATCHED 2N2905 & 2N2219	1572007	12597
Q0760	INTEGRATED CIRCUIT, CA3018	1580029	2735
Q0775	TRANSISTOR, 2N2905	1562905	1295
Q0780	TRANSISTOR, 2N2905	1562905	1295
Q0785	TRANSISTOR, 2N2219	1562219	1295
Q0790	TRANSISTOR, 2N2905	1562905	1295
Q0795	TRANSISTOR, 2N2219	1562219	1295
Q0800	OPERATIONAL AMPLIFIER, CA3030A	1580008	2735
Q0820	INTEGRATED CIRCUIT, UA710C	1580020	7263
Q0825	TRANSISTOR, 2N4121	1564121	7263
Q0830	TRANSISTOR, 2N4121	1564121	7263
Q1000	OPERATIONAL AMPLIFIER, CA3030A	1580008	2735
Q1020	OPERATIONAL AMPLIFIER, CA3030A	1580008	2735
Q1050	OPERATIONAL AMPLIFIER, CA3030A	1580008	2735
Q1060	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q1065	TRANSISTOR, 2N2484	1562484	7263
Q1080	INTEGRATED CIRCUIT, UA796C	1580796	1295
Q1085	TRANSISTOR, 2N4121	1564121	7263
Q1090	TRANSISTOR, MATCHED 2N4250	1574250	12597
Q1110	TRANSISTOR, MPS3646	1563646	4713
Q1120	TRANSISTOR, 2N4121	1564121	7263
R0100	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R0101	RESISTOR, 68K OHM 1/4W 5% CARBON	3070683	1121
R0110	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010	1121
R0111	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0112	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0113	RESISTOR, 3240 OHM 1/4W 1% METAL FILM	3133241	7115
R0114	RESISTOR, 9760 OHM 1/4W 1% METAL FILM	3139761	7115
R0115	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0120	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0121	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0125	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0130	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071022	1121
R0131	RESISTOR, 3300 OHM 1/4W 5% CARBON	3072332	1121
R0135	RESISTOR, 5100 OHM 1/4W 5% CARBON	3075112	1121
R0136	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0137	RESISTOR, 51 OHM 1/4W 5% CARBON	3070512	1121
R0140	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0141	RESISTOR, 1100 OHM 1/4W 1% METAL FILM	3131121	7115
R0150	RESISTOR, 150 OHM 1W 5% CARBON	3030151	1121
R0151	RESISTOR, 10K OHM 1/4W 5% CARBON	3071033	1121
R0160	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0161	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131821	7115
R0170	RESISTOR, 10K OHM 1/4W 5% CARBON	3071033	1121
R0171	RESISTOR, 470 OHM 1W 5% CARBON	3030471	1121
R0200	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0201	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0202	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0203	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0204	RESISTOR, 3920 OHM 1/4W 1% METAL FILM	3133921	7115
R0205	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0206	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0207	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0208	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R0209	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0210	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
R0211	RESISTOR, SELECTED VALUE		
R0212	TO		
R0222	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0224	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000	7115
R0225	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0226	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0227	RESISTOR, 562K OHM 1/4W 1% METAL FILM	3135623	7115
R0228	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0229	POTENTIOMETER, 2K OHM PC TRIM	3112130	78488
R0230	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0240	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0241	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0242	POTENTIOMETER, 100K OHM TRIM	3112143	71450
R0243	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0250	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0255	RESISTOR, 806 OHM MATCHED PAIR	3128060	12597
R0260	RESISTOR, 806 OHM MATCHED PAIR	3128060	12597
R0265	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0275	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0276	RESISTOR, 806 OHM MATCHED PAIR	3128060	12597
R0280	RESISTOR, 100 OHM 1/4W 5% CARBON	3071021	1121
R0285	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0290	RESISTOR, 100 OHM 1/4W 5% CARBON	3071021	1121
R0291	RESISTOR, 100000K OHM 1/4W 5% CARBON	3072106	1121
R0292	POTENTIOMETER, 100K OHM TRIM	3112143	71450
R0293	RESISTOR, 10K OHM 1/4W 5% CARBON	3071033	1121
R0300	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020	7115
R0301	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R0302	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134222	7115
R0304	RESISTOR, 8060 OHM MATCHED PAIR	3128061	12597
R0305	RESISTOR, 80600 OHM MATCHED PAIR	3128062	12597
R0306	SWITCH, ROTARY	2603331	12597
R0307	RESISTOR, 84500 OHM 1/4W 1% METAL FILM	3138452	7115
R0308	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0309	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0310	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0320	RESISTOR, 2700 OHM 1/4W 5% CARBON	3072272	1121
R0321	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0325	RESISTOR, 2700 OHM 1/4W 5% CARBON	3072272	1121
R0326	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0340	RESISTOR, 220 OHM 1/2W 5% CARBON	3012221	1121
R0350	RESISTOR, 383 OHM 1/4W 1% METAL FILM	3133830	7115
R0400	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R0401	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R0402	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0403	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531	7115
R0404	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020	7115
R0405	RESISTOR, 392 OHM 1/4W 1% METAL FILM	3133920	7115
R0406	RESISTOR, 274 OHM 1/4W 1% METAL FILM	3132740	7115
R0407	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531	7115
R0408	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0409	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0410	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0411	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0420	RESISTOR, 576 OHM 1/4W 1% METAL FILM	3135760	7115
R0430	RESISTOR, 5100 OHM 1/4W 5% CARBON	3075112	1121
R0431	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0432	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750	7115
R0435	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0436	RESISTOR, 5100 OHM 1/4W 5% CARBON	3075112	1121
R0437	RESISTOR, 715 OHM 1/4W 1% METAL FILM	3137150	7115
R0440	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0441	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0442	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750	7115
R0445	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0446	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0450	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0451	RESISTOR, 1200 OHM 1/4W 5% CARBON	3071122	1121
R0452	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074722	1121
R0453	RESISTOR, 100 OHM 1/4W 5% CARBON	3071021	1121
R0454	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074722	1121
R0455	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071022	1121
R0456	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0457	RESISTOR, 1200 OHM 1/4W 5% CARBON	3071122	1121
R0458	RESISTOR, 200 OHM 1/4W 5% CARBON	3072001	1121
R0459	RESISTOR, 200 OHM 1/4W 5% CARBON	3072001	1121
R0460	RESISTOR, 1200 OHM 1/4W 5% CARBON	3071122	1121
R0461	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0462	RESISTOR, 1200 OHM 1/4W 5% CARBON	3071122	1121
R0463	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0464	RESISTOR, 200 OHM 1/4W 5% CARBON	3072001	1121
R0500	RESISTOR, 10K OHM 1/4W 5% CARBON	3071033	1121
R0501	RESISTOR, 3900 OHM 1/4W 5% CARBON	3073922	1121
R0502	SWITCH, ROTART CONCENTRIC	2600334	12597
R0503	RESISTOR, 10K OHM 1/4W 5% CARBON	3071033	1121
R0504	RESISTOR, 330K OHM 1/4W 5% CARBON	3073334	1121
R0505	RESISTOR, 3000 OHM 1/4W 5% CARBON	3073022	1121
R0506	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0507	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074722	1121
R0508	RESISTOR, 100K OHM 1/4W 5% CARBON	3071034	1121
R0509	RESISTOR, 330K OHM 1/4W 5% CARBON	3073334	1121
R0520	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074722	1121
R0521	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074722	1121
R0522	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072202	1121
R0523	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821	1121
R0525	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R0526	RESISTOR, 4320 OHM 1/4W 5% CARBON	3074321	1121
R0527	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511	1121
R0528	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R0530	RESISTOR, 4300 OHM 1/4W 5% CARBON	3074321	1121
R0531	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071522	1121
R0600	POTENTIOMETER, 2K OHM PC TRIM	3112130	78488
R0601	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0602	RESISTOR, 82.5 OHM 1/4W 1% METAL FILM	3138251	7115
R0603	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0604	POTENTIOMETER, 2K OHM PC TRIM	3112130	78488
R0605	RESISTOR, 309 OHM 1/4W 1% METAL FILM	3133090	7115
R0606	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531	7115
R0607	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0608	POTENTIOMETER, 2K OHM PC TRIM	3112130	78488
R0609	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0610	RESISTOR, 19100 OHM 1/4W 1% METAL FILM	3131912	7115
R0611	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531	7115
R0612	POTENTIOMETER, 2K OHM PC TRIM	3112130	78488
R0613	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0614	RESISTOR, 19100 OHM 1/4W 1% METAL FILM	3131912	7115
R0615	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3134990	7115
R0616	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R0617	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R0618	RESISTOR, 120 OHM 1/4W 5% CARBON	3071210	1121
R0619	RESISTOR, 100 OHM 1/4W 5% CARBON	3071010	1121
R0620	RESISTOR, 100 OHM 1/4W 5% CARBON	3071010	1121
R0621	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0622	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0623	RESISTOR, 681 OHM 1/4W 1% METAL FILM	3136810	7115
R0624	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R0625	POTENTIOMETER, 100K OHM TRIM	3112143	71450
R0626	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115
R0627	POTENTIOMETER, 100 OHM TRIM	3112141	71450
R0628	RESISTOR, 63.4 OHM 1/4W 1% METAL FILM	3136340	7115
R0630	RESISTOR, 39 OHM 1/4W 5% CARBON	3073910	1121
R0631	RESISTOR, 330 OHM 1/2W 5% CARBON	3213311	1121
R0635	RESISTOR, 39 OHM 1/4W 5% CARBON	3073910	1121
R0636	RESISTOR, 2400 OHM 1/4W 5% CARBON	3072242	1121
R0645	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0646	RESISTOR, 249 OHM 1/4W 1% METAL FILM	3132490	7115
R0647	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115
R0648	POTENTIOMETER, 2K OHM PC TRIM	3112130	78488
R0649	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0650	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0651	RESISTOR, 3000 OHM 1/4W 5% CARBON	3073022	1121
R0652	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R0671	RESISTOR, 51 OHM 1/4W 5% CARBON	3070512	1121
R0672	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0674	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0675	RESISTOR, 51 OHM 1/4W 5% CARBON	3070512	1121
R0676	RESISTOR, 15 OHM 1/4W 5% CARBON	3071510	1121
R0677	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R0678	SWITCH, ROTARY	2603329	12597
R0709	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121

PART	DESCRIPTION	EXACT NO	MFG
R0/10	POTENTIOMETER, 10K OHM WITH SWITCH	3110333	71450
R0/12	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0/14	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0/15	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0/16	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0/17	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0/18	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R0/19	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R0/20	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R0/21	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0/22	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0/23	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0/25	RESISTOR, 301 OHM 1/2W 1% METAL FILM	3103010	7115
R0/26	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0/30	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R0/31	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R0/32	RESISTOR, 47.5 OHM 1/2W 1% METAL FILM	3100475	7115
R0/33	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3132261	7115
R0/34	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3133481	7115
R0/35	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3132261	7115
R0/36	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0/37	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R0/38	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R0/39	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R0/40	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R0/41	RESISTOR, 3.16 OHM 1/8W 1% DEP. CARBON	3193160	7115
R0/42	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R0/43	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R0/44	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0/45	RESISTOR, 332 OHM 1/4W 5% CARBON	3073331	1121
R0/46	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R0/50	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R0/51	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0/52	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0/55	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0/56	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0/57	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R0/59	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0/62	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0/63	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R0/64	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0/65	RESISTOR, 1.6 OHM 1/4W 5% CARBON	3070101	1121
R0/66	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R0/67	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0/68	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R0/69	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0/70	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R0/71	RESISTOR, 14.0 OHM 1/8W 1% METAL FILM	3140100	7115
R0/72	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0/73	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0/75	RESISTOR, 301 OHM 1/2W 1% METAL FILM	3103010	7115
R0/76	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0/77	RESISTOR, 1911 OHM 1/4W 1% METAL FILM	3131911	7115
R0/78	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331	1121
R0/85	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R0/86	RESISTOR, 47.5 OHM 1/2W 1% METAL FILM	3100475	7115
R0/87	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0/90	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0/91	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R0/95	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R0820	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0861	SWITCH, ROTARY	2600337	10597
R0862	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0803	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0804	RESISTOR, 2370 OHM 1/4W 1% METAL FILM	3132371	7115
R0805	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R0806	RESISTOR, 100K OHM 1/4W 5% CARBON	3070105	1121
R0807	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0808	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681	1121
R0809	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0810	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682	1121
R0811	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0812	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0813	POTENTIOMETER, 10K OHM TRIM	3110132	71450
R0814	RESISTOR, 27 OHM 1/4W 5% CARBON	3070272	1121
R0815	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0816	RESISTOR, 1620 OHM 1/4W 5% CARBON	3071162	1121
R0817	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0818	RESISTOR, 1620 OHM 1/4W 5% CARBON	3071162	1121
R0820	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0821	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0822	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0825	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0826	RESISTOR, 6200 OHM 1/4W 5% CARBON	3076222	1121
R0827	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0828	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0832	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0831	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1002	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R1001	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1002	RESISTOR, 1240K OHM 1/4W 1% METAL FILM	3131204	7115
R1003	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1004	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R1005	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681	1121
R1006	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R1007	RESISTOR, 8871 OHM 1/4W 1% METAL FILM	3138871	7115
R1008	POTENTIOMETER, 2K OHM PC TRIM	3110132	78488
R1009	POTENTIOMETER, 1M OHM	3110197	44655
R1010	RESISTOR, 84500 OHM 1/4W 1% METAL FILM	3138262	7115
R1011	POTENTIOMETER, 1MK OHM MIN	3110327	71450
R1012	RESISTOR, 22100 OHM 1/4W 1% METAL FILM	3132212	7115
R1013	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R1014	RESISTOR, 10007 OHM 1/4W 1% METAL FILM	3131782	7115
R1015	RESISTOR, 1800 OHM 1/4W 5% CARBON	3071182	1121
R1018	RESISTOR, 634 OHM 1/4W 1% METAL FILM	3136342	7115
R1020	RESISTOR, 1270 OHM 1/4W 5% CARBON	3071122	1121
R1021	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R1022	RESISTOR, 26100 OHM 1/4W 1% METAL FILM	3132612	7115
R1023	POTENTIOMETER, 5K OHM TRIM	3111149	71450
R1024	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R1025	RESISTOR, 680 OHM 1/4W 5% CARBON	3076681	1121
R1026	RESISTOR, 152 OHM 1/4W 5% CARBON	3070151	1121

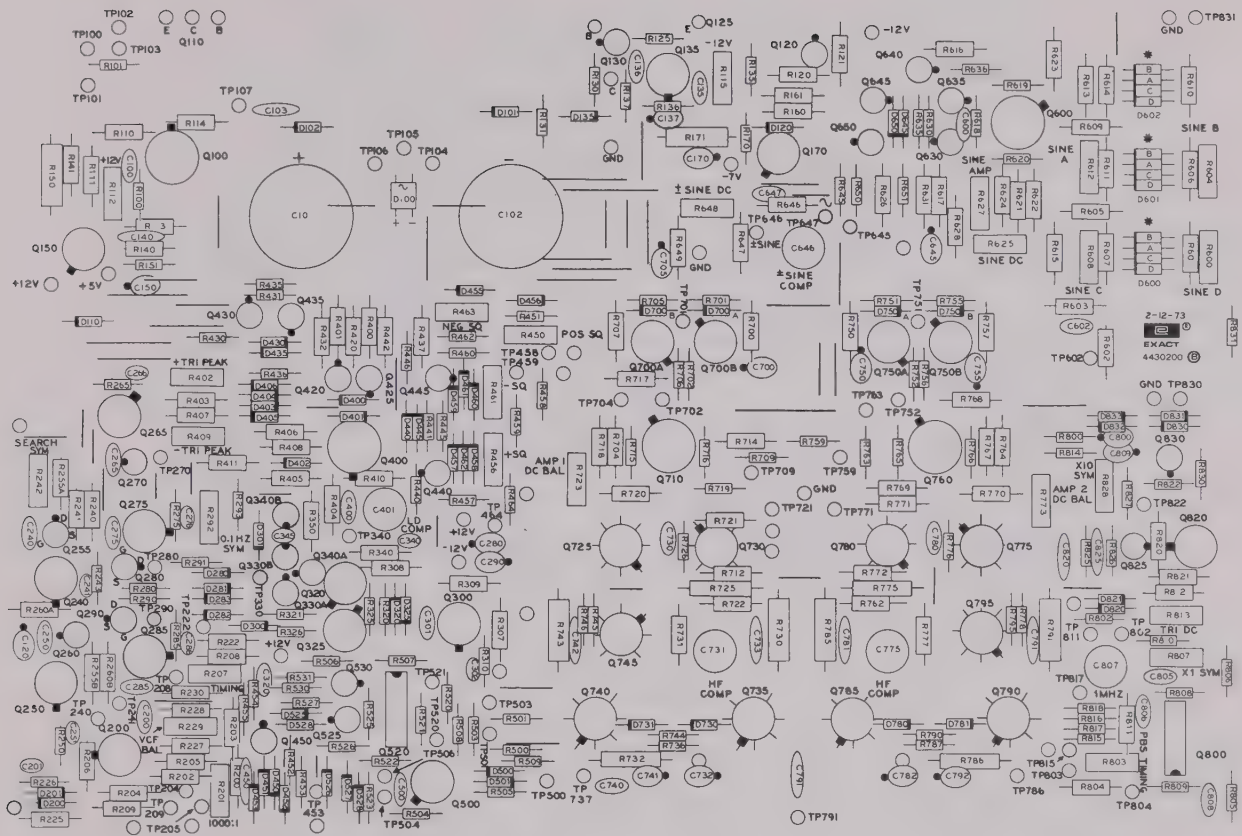
PART	DESCRIPTION	EXACT NO	MFG
R1027	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R1028	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R1030	RESISTOR, 9760 OHM 1/4W 1% METAL FILM	3139761	7115
R1031	RESISTOR, 9760 OHM 1/4W 1% METAL FILM	3139761	7115
R1032	RESISTOR, 309 OHM 1/4W 1% METAL FILM	3133090	7115
R1033	RESISTOR, 10200 OHM 1/4W 1% METAL FILM	3131802	7115
R1034	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131802	7115
R1035	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R1036	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R1037	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R1038	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R1039	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R1050	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1051	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R1052	RESISTOR, 120K OHM 1/4W 5% CARBON	3070124	1121
R1053	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R1054	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R1055	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070202	1121
R1056	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1057	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681	1121
R1058	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115
R1060	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R1061	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1062	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R1063	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1064	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1065	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R1066	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1067	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1068	RESISTOR, SELECTED VALUE		
R1069	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R1070	RESISTOR, 10500 OHM 1/4W 1% METAL FILM	3131052	7115
R1071	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1080	POTENTIOMETER, 250 OHM	3110145	71450
R1081	RESISTOR, 3160 OHM 1/4W 1% METAL FILM	3133161	7115
R1082	RESISTOR, 1270 OHM 1/4W 1% METAL FILM	3131271	7115
R1084	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R1085	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R1090	RESISTOR, 619 OHM 1/4W 1% METAL FILM	3136190	7115
R1091	RESISTOR, 619 OHM 1/4W 1% METAL FILM	3136190	7115
R1092	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1093	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R1094	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1095	RESISTOR, 10500 OHM 1/4W 1% METAL FILM	3131052	7115
R1096	RESISTOR, 24.3 OHM 1/8W 1% METAL FILM	3100243	7115
R1097	RESISTOR, 24.3 OHM 1/8W 1% METAL FILM	3100243	7115
R1098	RESISTOR, 604 OHM 1/4W 1% METAL FILM	3136040	7115
R1099	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R1100	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R1101	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1102	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R1103	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R1104	RESISTOR, 100 OHM THERMISTOR	3171000	1295
R1110	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R1111	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R1112	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R1113	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R1114	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R1115	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1120	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R1121	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R1122	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
S0100	SWITCH, TOGGLE SPDT	2600103	100005
S0101	SWITCH, SLIDE	2600323	10597
S0200	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0330	SWITCH, ROTARY	2600331	10597
S0300	SWITCH, ROTARY CONCENTRIC	2600334	10597
S0320	SWITCH, PUSH BUTTON	2600318	10597
S0700	SWITCH, ROTARY	2600329	10597
S0740	SWITCH, PUSH BUTTON	2600332	10597
S0800	SWITCH, ROTARY	2600330	10597
S1000	SWITCH, PUSHBUTTON	2600366	10597
S1001	SWITCH, TOGGLE SPDT	2600087	100005
T0100	TRANSFORMER, POWER	1200039	10597

SECTION 6

PARTS OVERLAY

AND

SCHEMATICS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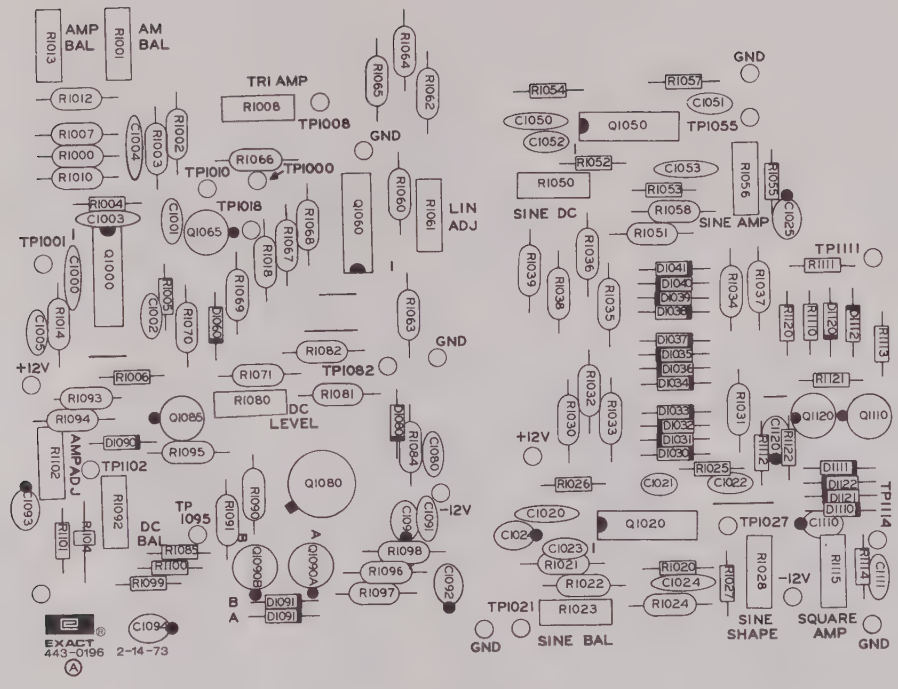
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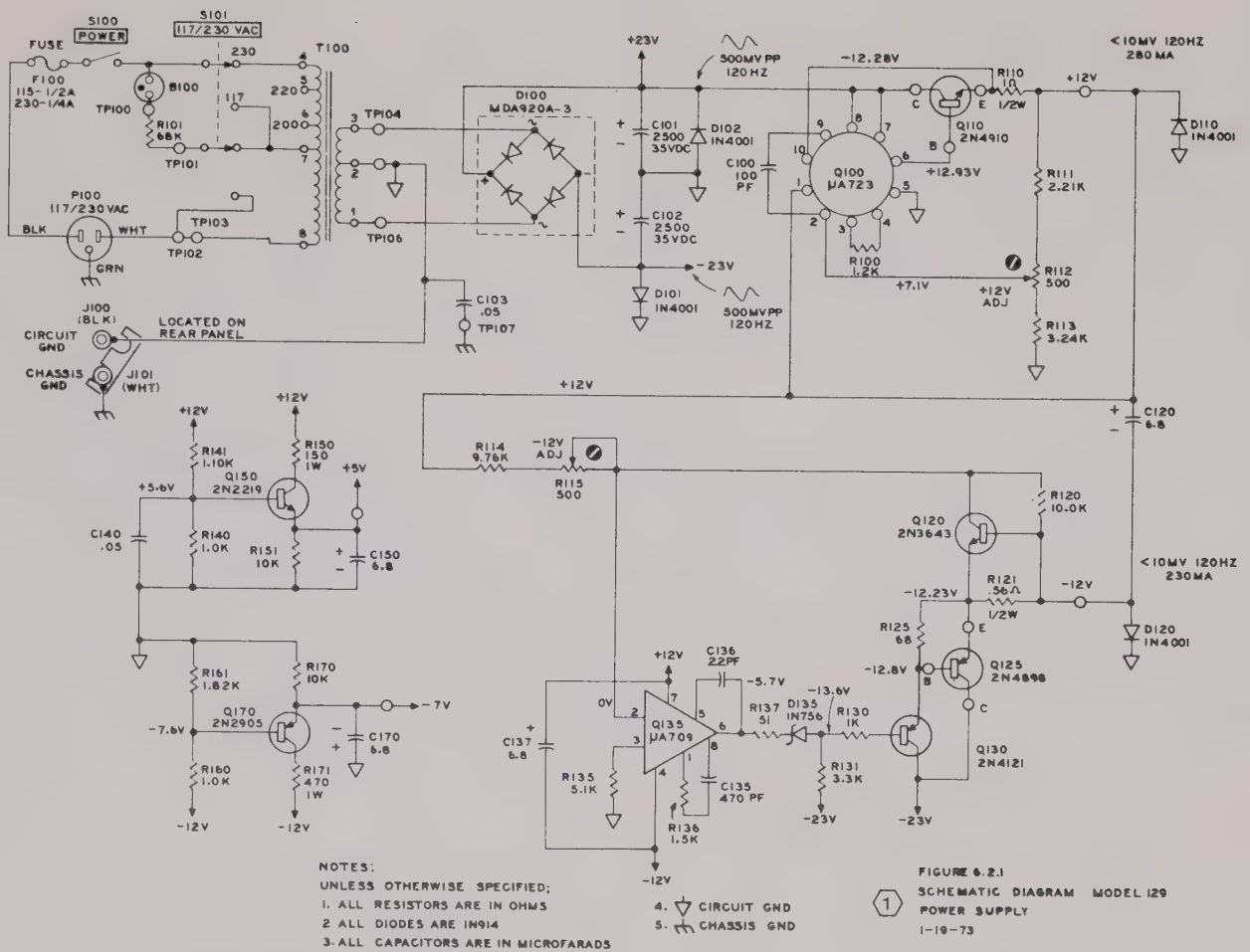
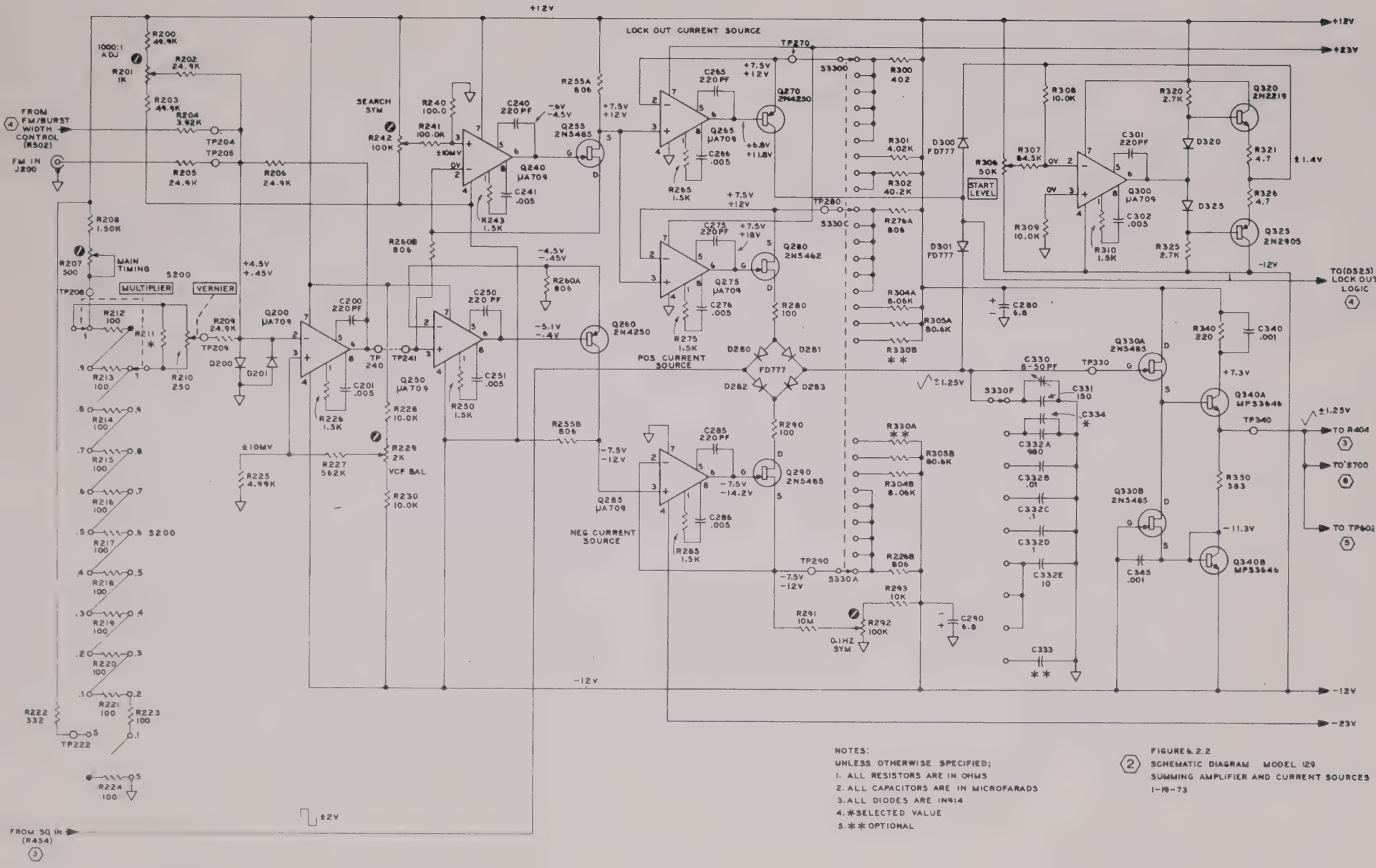
SINE AMP
TP1111
+12V
TP1027
TP1114
TP1021
SINE BAL
SINE SHAPE
SQUARE AMP
-12V
GND

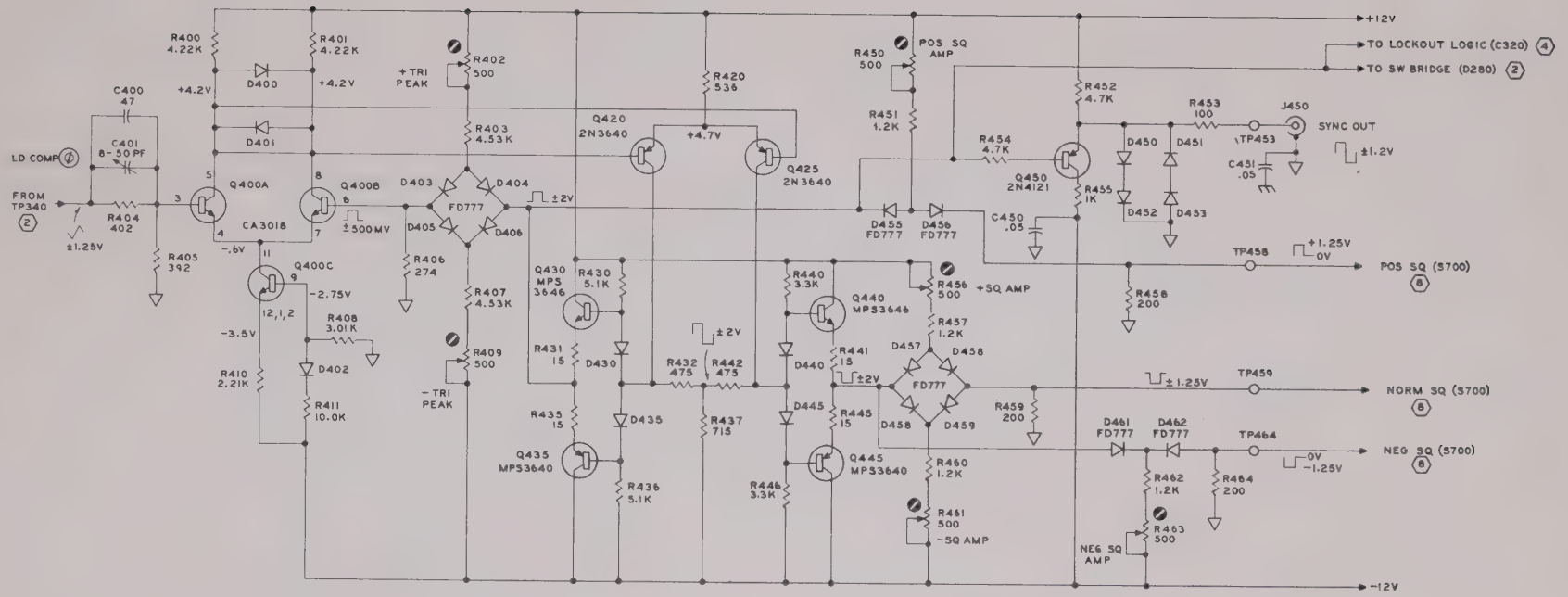


NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2 ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS

4. ▽ CIRCUIT GND
5. ⏚ CHASSIS GND

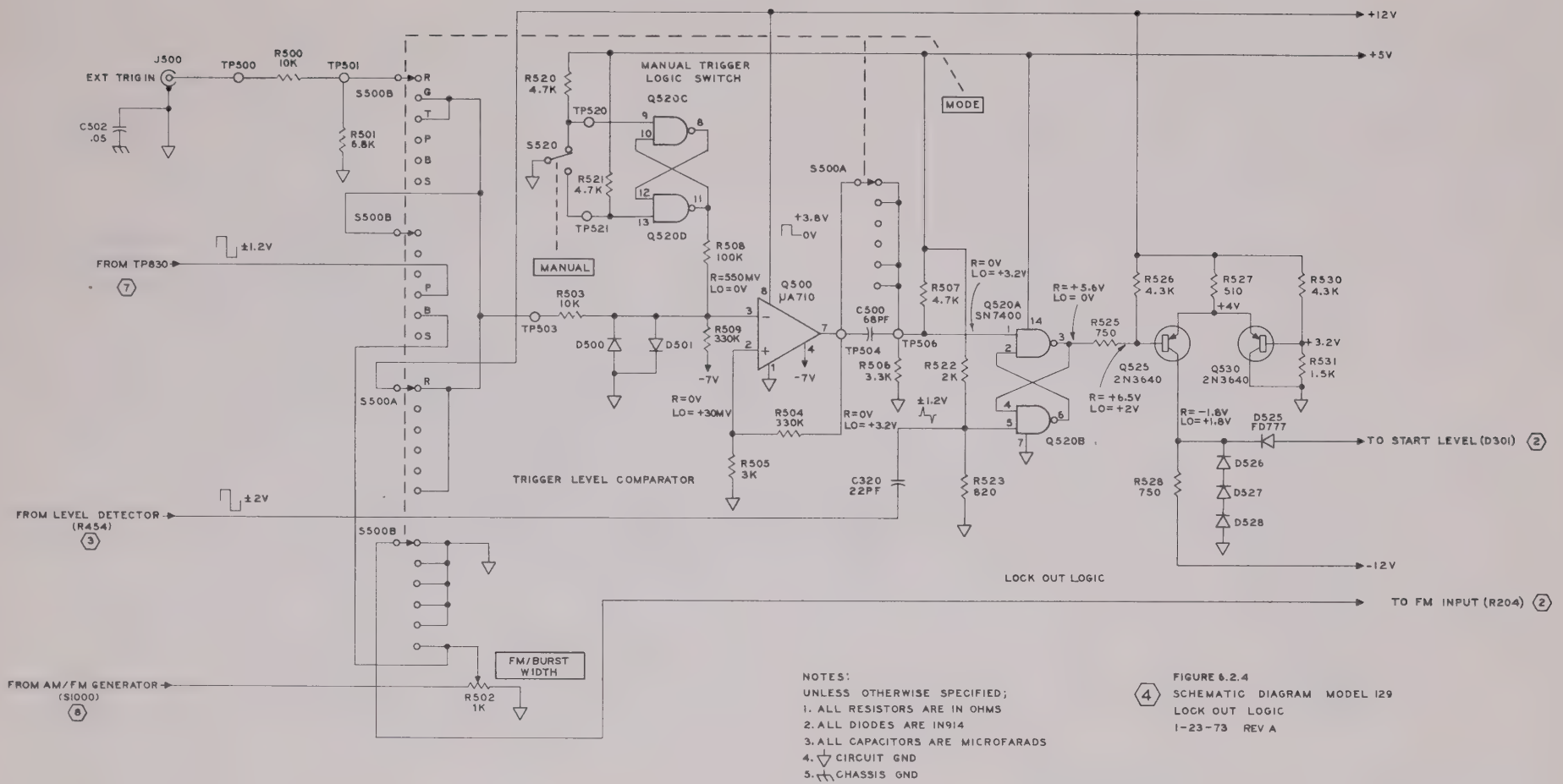
FIGURE 6.2.1
SCHEMATIC DIAGRAM MODEL 129
POWER SUPPLY
1-19-73


+12V
LOCK OUT CURRENT SOURCE
TP270
S3300
R300 402
R301 4.02K
R302 40.2K
R276A 806
S3300C
TP280
R304A 8.06K
R305A 80.6K
R304B 8.06K
R305B 80.6K
R330A **
R226B 806
S3300A
TP290
R293 10K
R291 10M
R292 100K
0.1HZ SYM
C290 6.8
C333 **
R255A 806
R255B 806
C265 220PF
Q270 2N4250
Q265 µA709
C266 .005
R265 1.5K
C275 220PF
Q280 2N5462
Q275 µA709
C276 .005
R275 1.5K
C285 220PF
Q290 2N5485
Q285 µA709
C286 .005
R285 1.5K
R280 100
R290 100
D280
D281
D282
D283
FD777
POS CURRENT SOURCE
NEG CURRENT SOURCE
Q260 2N4250
R260A 806
R260B 806
-4.5V -.45V
-5.1V -.4V
-7.5V -12V
-7.5V -14.2V
+7.5V +12V
+7.5V +18V
+6.8V +11.8V
-6V -4.5V
+7.5V +12V
FROM FM/BURST WIDTH CONTROL (R502)
FM IN J200
SEARCH SYM
R240 100.0
R241 100.0K
R242 100K
±10MV
0V
R243 1.5K
C240 220PF
Q255 2N5485
Q240 µA709
C241 .005
1000:1 ADJ
R200 49.9K
R201 1K
R202 24.9K
R203 49.9K
R204 3.92K
TP204
TP205
R205 24.9K
R206 24.9K
R208 1.50K
R207 500
MAIN TIMING
S200
MULTIPLIER
VERNIER
TP208
R212 100
R211 *
R209 24.9K
TP209
R213 100
R210 250
R214 100
R215 100
R216 100
R217 100
R218 100
R219 100
R220 100
R221 100
R222 332
R223 100
TP222
R224 100
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
+4.5V +.45V
Q200 µA709
C200 220PF
D200
D201
R227 562K
R225 4.99K
R226 1.5K
Q250 µA709
C250 220 PF
C251 .005
R250 1.5K
TP240
TP241
R228 10.0K
R229 2K
VCF BAL
R230 10.0K
±2V
FROM SQ IN (R454)
3
Q300 µA709
C301 220PF
C302 .003
R306 50K
START LEVEL
R307 84.5K
R308 10.0K
R309 10.0K
R310 1.5K
D300 FD777
D301 FD777
R320 2.7K
R321 4.7
R325 2.7K
R326 4.7
Q320 2N2219
Q325 2N2905
D320
D325
±1.4V
-12V
TO(D525) LOCK OUT LOGIC
4
C280 6.8
C330 8-50PF
TP330
Q330A 2N5485
Q330B 2N5485
C331 150
C334 *
C332A 980
C332B .01
C332C .1
C332D 1
C332E 10
C345 .001
R340 220
C340 .001
Q340A MPS3646
Q340B MPS3646
+7.3V
-11.3V
±1.25V
TP340
TO R404
TO S700
TO TP602
R350 383
S3300F
-23V
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. *SELECTED VALUE
5. ** OPTIONAL
2
FIGURE 6.2.2
SCHEMATIC DIAGRAM MODEL 129
SUMMING AMPLIFIER AND CURRENT SOURCES
1-19-73



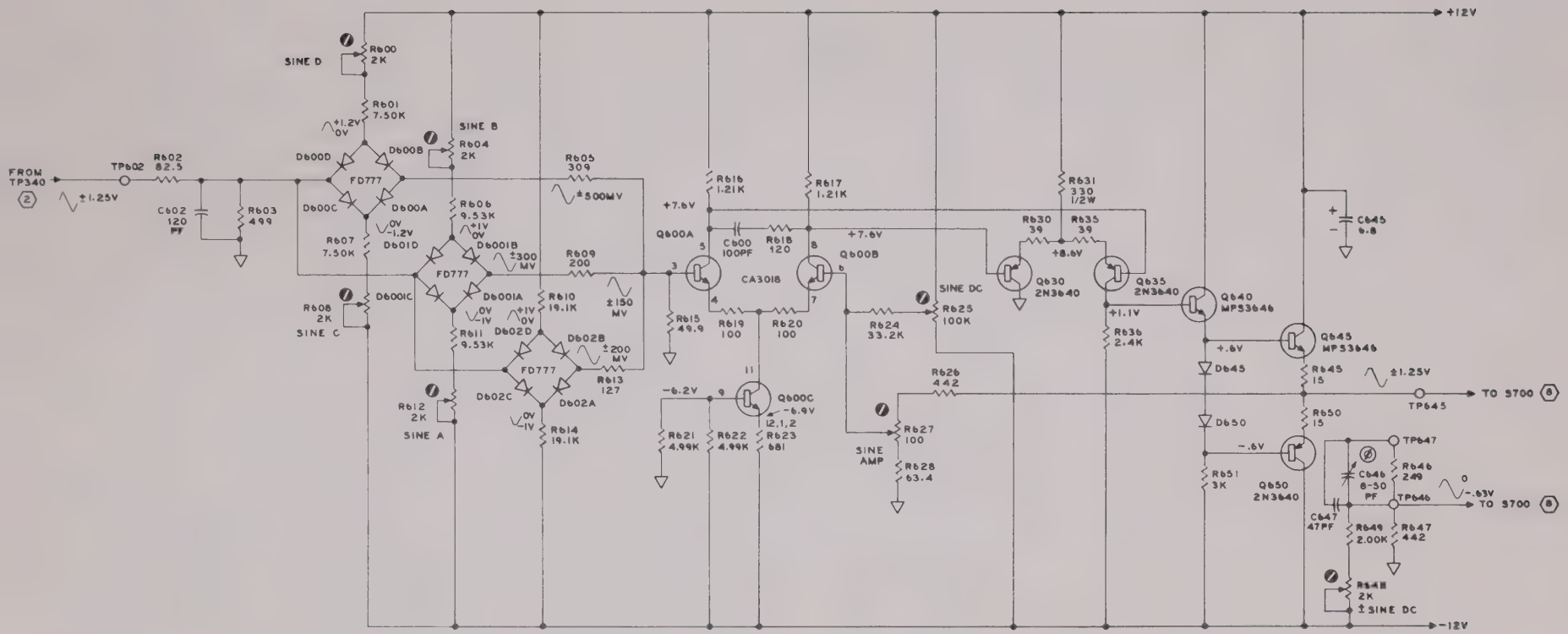
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. ⏚ CIRCUIT GND

FIGURE 6.2.3
3 SCHEMATIC DIAGRAM - MODEL 129
LEVEL DETECTOR/BISTABLE SWITCH
1-23-73 REV A



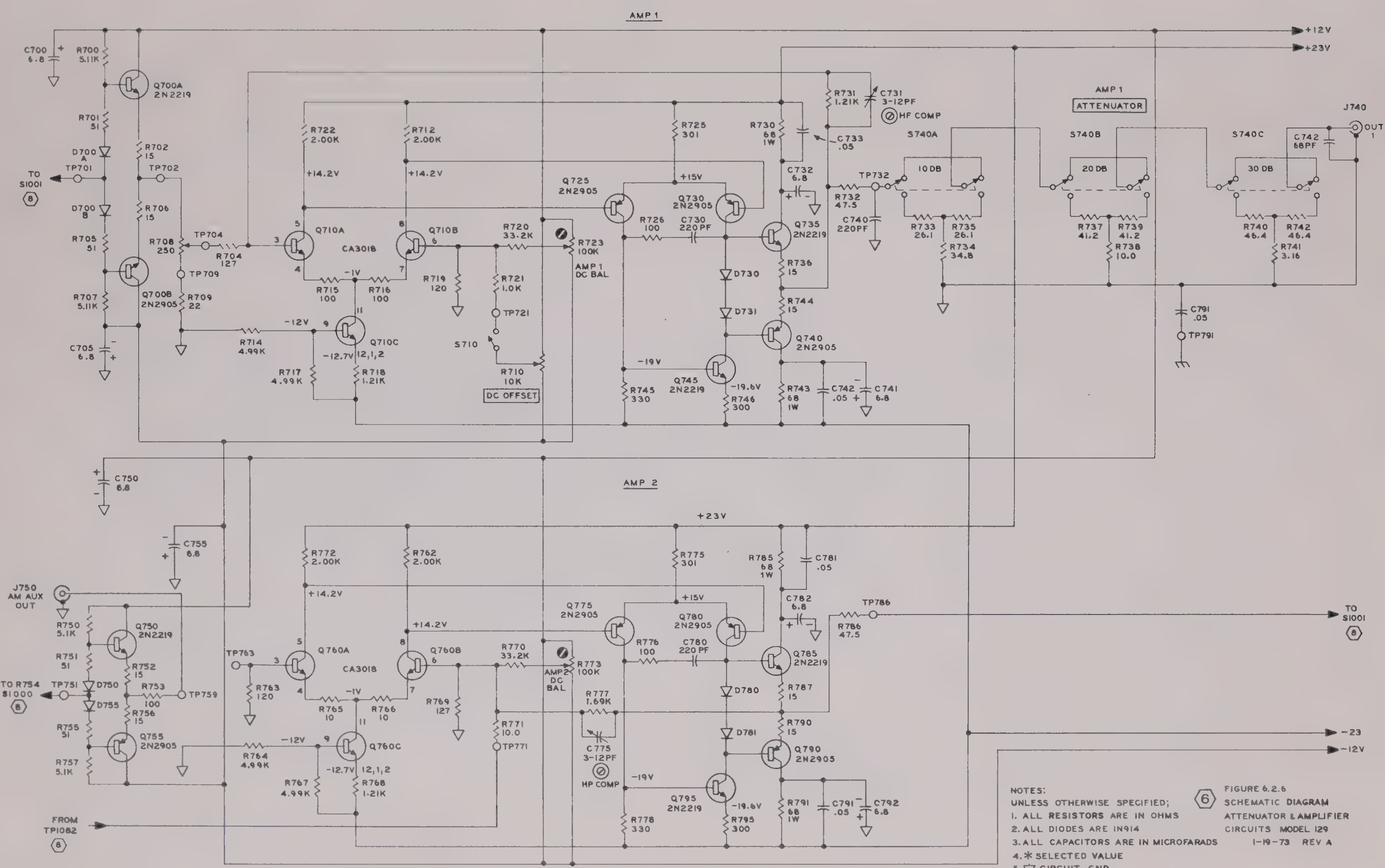
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE MICROFARADS
4. ▽ CIRCUIT GND
5. ⏚ CHASSIS GND

4 FIGURE 6.2.4
SCHEMATIC DIAGRAM MODEL 129
LOCK OUT LOGIC
1-23-73 REV A



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. ⏚ CIRCUIT GND

FIGURE 6.2.5
(5) SCHEMATIC DIAGRAM MODEL 129
SINE SHAPER / SINE AMP CIRCUIT
1-23-73

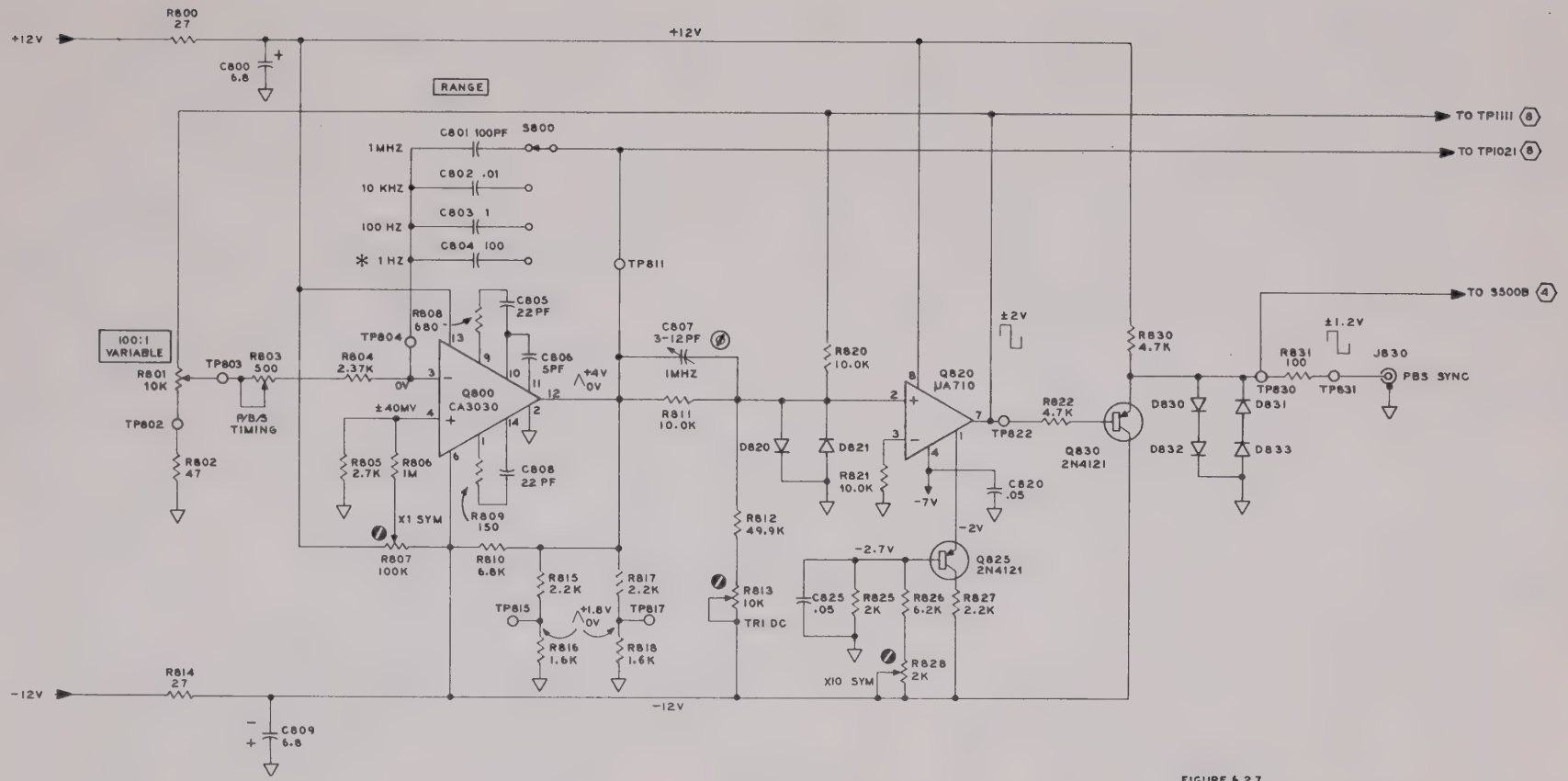


AMP 1
+12V
+23V
C700 6.8
R700 5.11K
Q700A 2N2219
R701 51
D700 A
TO S1001 8
TP701
D700 B
R705 51
R702 15
TP702
R706 15
R708 250
TP704
R704 127
TP709
R709 22
Q700B 2N2905
R707 5.11K
C705 6.8
R722 2.00K
R712 2.00K
+14.2V
Q710A
CA3018
Q710B
R715 100
R716 100
-1V
R714 4.99K
-12V
Q710C
-12.7V
12,1,2
R717 4.99K
R718 1.21K
R719 120
R720 33.2K
R721 1.0K
TP721
S710
R710 10K
DC OFFSET
R723 100K
AMP 1 DC BAL
Q725 2N2905
R725 301
+15V
Q730 2N2905
R726 100
C730 220 PF
D730
D731
-19V
Q745 2N2219
-19.6V
R745 330
R746 300
R730 68 1W
R731 1.21K
C731 3-12PF
HF COMP
C733 .05
C732 6.8
Q735 2N2219
R736 15
R744 15
Q740 2N2905
R743 68 1W
C742 .05
C741 6.8
R732 47.5
TP732
C740 220PF
AMP 1
ATTENUATOR
S740A
10 DB
R733 26.1
R735 26.1
R734 34.8
S740B
20 DB
R737 41.2
R739 41.2
R738 10.0
S740C
30 DB
R740 46.4
R742 46.4
R741 3.16
C742 68PF
J740
OUT 1
C791 .05
TP791
C750 6.8
AMP 2
+23V
C755 6.8
J750 AM AUX OUT
R750 5.1K
Q750 2N2219
R751 51
R752 15
TO R754 S1000 8
TP751
D750
D755
R753 100
TP759
R756 15
R755 51
Q755 2N2905
R757 5.1K
FROM TP1082 8
R772 2.00K
R762 2.00K
+14.2V
TP763
R763 120
Q760A
CA3018
Q760B
R765 10
R766 10
-1V
R764 4.99K
-12V
Q760C
-12.7V
12,1,2
R767 4.99K
R768 1.21K
R769 127
R770 33.2K
R771 10.0
TP771
R773 100K
AMP2 DC BAL
R777 1.69K
C775 3-12PF
HP COMP
Q775 2N2905
R775 301
+15V
Q780 2N2905
R776 100
C780 220 PF
D780
D781
-19V
Q795 2N2219
-19.6V
R778 330
R795 300
R785 68 1W
C781 .05
C782 6.8
Q785 2N2219
R787 15
R790 15
Q790 2N2905
R791 68 1W
C791 .05
C792 6.8
R786 47.5
TP786
TO S1001 8
-23
-12V

NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. * SELECTED VALUE
5. ▽ CIRCUIT GND
6. CHASSIS GND

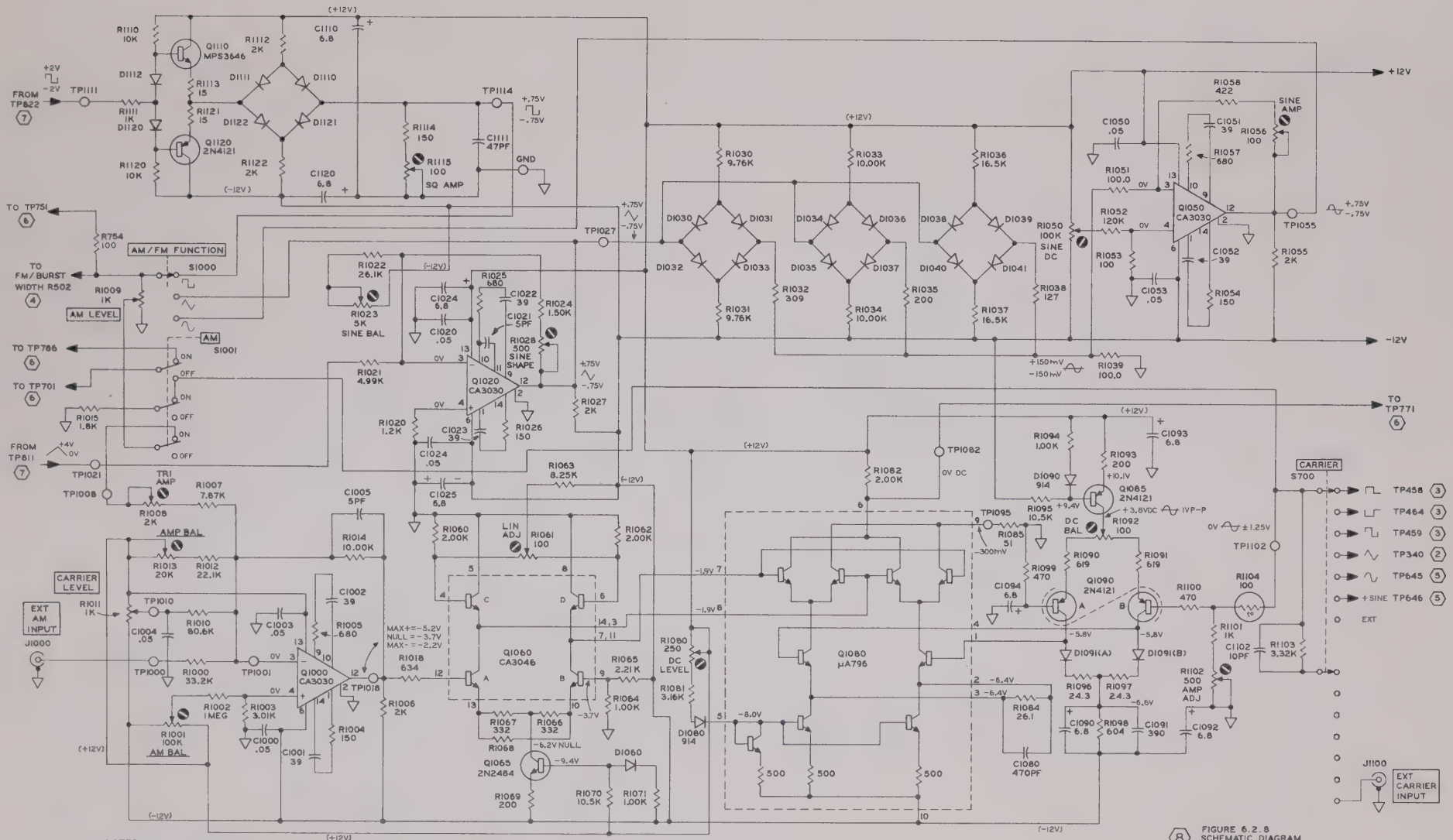
6

FIGURE 6.2.6
SCHEMATIC DIAGRAM
ATTENUATOR & AMPLIFIER
CIRCUITS MODEL 129
1-19-73 REV A



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. * SELECTED VALUE - OPTIONAL
5. ⏚ CIRCUIT GND

(7) FIGURE 6.2.7
SCHEMATIC DIAGRAM MODEL 129
AM/FM GENERATOR
1-19-73
REV A



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL DIODES ARE 914'S.
2. ALL RESISTORS IN OHMS.
3. ALL CAPACITORS ARE IN MICROFARAD.

8 FIGURE 6.2.8
SCHEMATIC DIAGRAM
AM BRD
MODEL 129
1-29-73 REV A

SECTION 7

ADDENDA

ADDENDUM
Model 129

Error in power supply Schematic Figure 7.2.1.
Transformer T100 shows instrument wired to pin 4
(230V), should be shown wired to pin 5 (220).

DANA EXACT ELECTRONICS, INC.
1-20-75

ADDENDA

Model 129

On schematic (6): Change R 773 from 100K to 2.5K (3110148)

On schematic (8): Make R 1068 a 4.99K (3134991)

Change R 1022 from 26.1K to 30.1K (3133012)

Change R 1081 from 3.16K to 2.94K (3132941)

Change C 1021 from a 5 pf to a 10 pf (2890529)

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4-24-75